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1 Investigation of Malaria in the District of Katha

2 Report on Certain features of Malaria in the island of Salsette.

3 Proceedings of the 3rd Meeting of the General Malaria Committee held at Madras, Nov. 18.19.20, 1912

4 Repal of the Managing Committee of Bombay Central Famine Relief Fund 1911-12

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INVESTIGATION OF MALARIA

IN THE

DISTRICT OF KATHA

RANGOON: OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, BURMA. SEPT. 1913.

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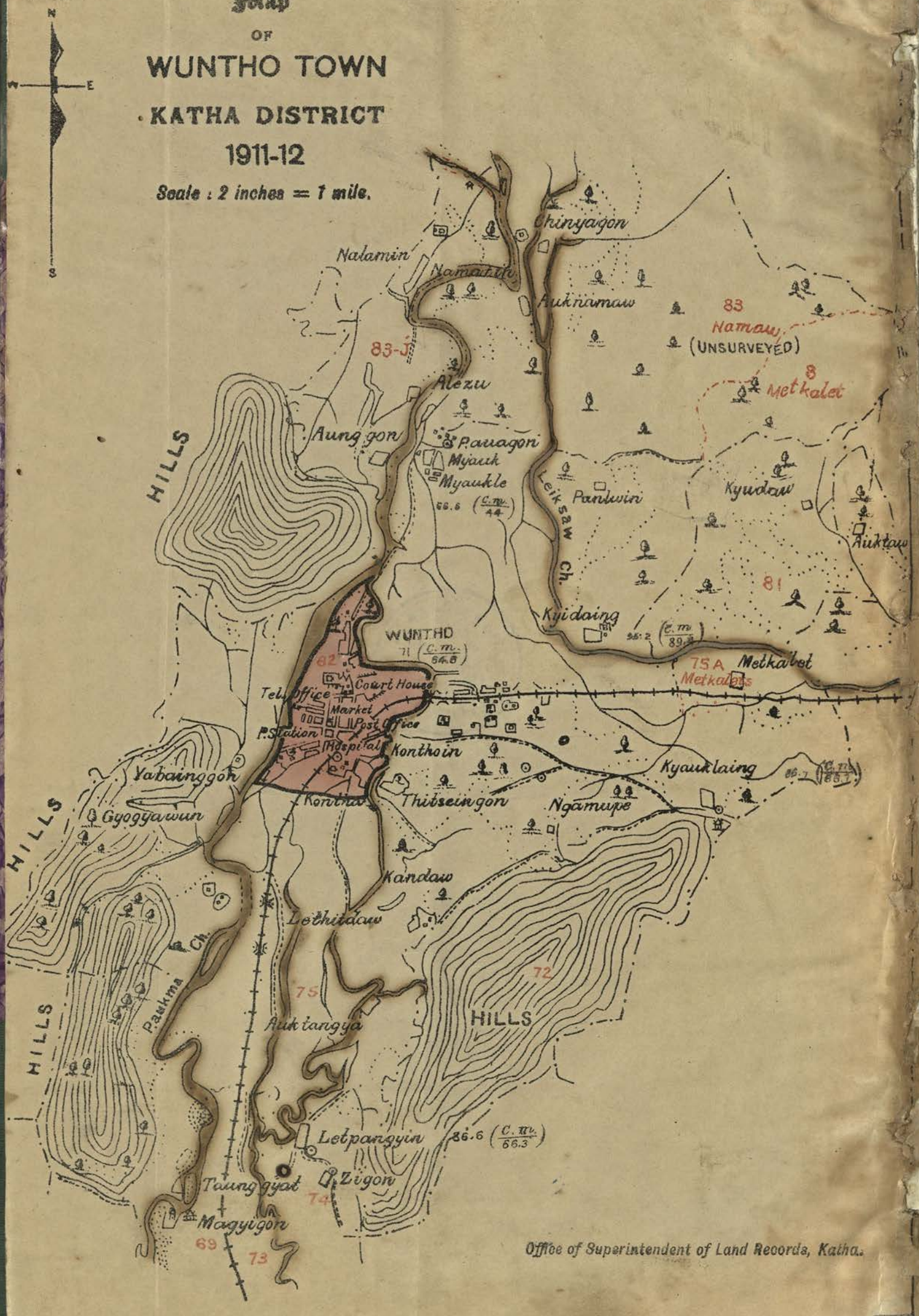
Map
OF
WUNTHO TOWN
KATHA DISTRICT
1911-12
Scale : 2 inches = 1 mile.



G.S.C.P.O.—No. 91, I.G.C.H., 25-3-1913. 200. L.M.

INVESTIGATION OF MALARIA IN THE DISTRICT OF KATHA.

INTRODUCTION

The localities where malaria prevails in the province of Burma are roughly divisible into three types:—

1. Low-lying marshy areas on the sea littoral.

2. Areas in the submontane tracts where forest jungle abounds, plentifully watered by perennial streams from the hills above.

3. Low-lying waterlogged areas near the banks of the large rivers where marshy conditions persist throughout the year.

Differing in the nature of their Anopheline fauna, in the extent to which indigenous malaria prevails, and the variations to which it is subject from year to year: differing as regards presence or otherwise of economic conditions which favour malarial incidence—there is one natural feature which is common to localities of all three types, and this consists in the presence of perennial streams or marshes bordered by rank and decaying vegetation.

The town of Kyaukpyu and its *entourage*—a type area of the first class—was examined and reported upon from a malarial standpoint last year.

The town of Wuntho with its neighbourhood, subsequently selected as the most suitable area in Katha District for examination and report, is a type area of the second class. The results of investigation into the causes of, and prevalence of, malaria at Wuntho form the subject-matter of the present report.

In Katha District malaria is unfortunately rife. The figures shown in the following table, which exhibit the percentage spleen rate amongst children below the age of ten years at various centres of population in the district, lend precision to this view:—

Percentage spleen rate amongst children below the age of ten years at various centres in Katha District.

Town or Village.	Number of children examined.	Percentage spleen rate.
Pinzaw	20	85
Naba	50	84
Wuntho	50	74
Pingaying	65	72
Pinlebu	50	70
Binbegôn	35	66
Mansi and neighbouring villages	150	63·33
Pintha	50	58
Ongôngaon	50	40
Mohnyin	250	38·4
Banmauk	200	35
Mithijho	25	32
Emheen	100	19
Machikaon	50	16
Seto	200	16
Katha	125	15·28

From the table it is apparent, that Wuntho occupies unenviable preeminence amongst centres affected. Though not the worst centre in Katha District, it is one of the worst relatively, and—in actual number of human beings affected—the worst absolutely.

The district as a whole is described as large, hilly, and sparsely populated. It lies for the most part on the west bank of the Irrawaddy. Three main ranges traverse it roughly from north to south, separating its principal streams. These ranges, of no great height, are alike in being clothed with dense tree jungle containing much teak and other valuable timber, besides considerable quantities of bamboo. The terai at the foot of the hills is described as very unhealthy and merits that description during and after the rains.

In the hot weather atmospheric temperature all over the district is stated to be considerable, and the absence of wind at this season and in the rains is calculated to favour mosquito-borne infection. The daily shade temperature—irregularly recorded—shows maxima of 75° F. in the cold season, 105° F. in the hot weather and 95° F. in the rains. The minimum recorded temperature in the cold season at night is 45° F.

The average rainfall at Katha itself is 58 inches, and varies elsewhere in the district from 42 inches at Tigyaing in the plains, to 67 inches in the hills at Banmauk. In September and October during the latter rains, small flies of the families *Chironomidæ* (Ceratopogon), and *Psychodidæ*, bite viciously. These flies constitute the bulk of local sandflies,—abundant in the writer's experience at Wuntho and the neighbouring town of Kawlin,—and reported to prevail coincidently in the district elsewhere.

The physical conditions of Wuntho and its surroundings are more or less those of other affected areas in the district. The town is situated in the midst of a fertile valley surrounded by tree-covered hills. Those to the north-west constitute the Maugin range, the highest summit of which is Maing-thôn, 5,450 feet. The town—which adjoins the hills on the west, separated from them by a small river called the Daingyu *chaung*—is built irregularly around the bases of two knolls. On the southern of these is located the railway bungalow with the house of the Subdivisional Officer, and on the northern the Military Police barracks with the Circuit House. The railway line runs between both knolls, cutting off three-fourths of the inhabited area to the north and west.

The Wuntho *chaung*, an offset of the small river, starting at the northern extremity of the town winds southwards irregularly around it and bounds it to the east. The Wuntho *chaung* is largely an irrigation cut, into which the water of the Daingyu *chaung* is diverted by a dam. Dams are made in the course of the Wuntho *chaung* to confine its water to selected areas as required, and a subsidiary irrigation cut, which short circuits the Wuntho *chaung* through the east of the town, passes below the knoll on which the Circuit House stands. Water in these irrigation cuts is stagnant when they are full; when they are empty a number of pools are left, which take ten days or more in the dry season to disappear.

There is no time of the year when one or other condition does not exist, and as water stagnates whether these irrigation cuts are full or empty, exceptional facilities are afforded for Anopheles mosquito breeding,—at the grassy margins of the filled cut in one case,—in the rubbish and dèbris which cover the surface

of drying pools in the other. In the rainy season these cuts, as well as the larger stream, communicate with temporary marshes in which anopheles breed.

That marshes must form in the rains is a necessity. But the essential element in malarial prevalence and spread at Wuntho appears—as in the case of Kyaukpyu—to be associated, not with such temporary collections, but with the continued presence of stagnant water all the year around.

Paddy cultivation, *per se*, appears to play a minor part in maintaining a water-logged condition of the soil in the dry season at Wuntho; for, though the town is surrounded by a large area of paddy cultivation, this is reaped in the month of November, and it is then possible by closing the irrigation cuts, to do away with the great majority of mosquito-breeding haunts during the cold season and hot weather. To the extent to which this is feasible Anopheline fauna can be reduced in number, with corresponding reduction in the importance of their rôle—as carriers of human malaria. But this is not the only advantage which may be expected to follow the adoption of such a measure; for it is within the limits of probability that the *fons et origo* of human malaria is bound up with the existence of perennial marshes and stagnant water—apart from the mosquito-breeding facilities they afford.

Certain facts discovered by the writer in the course of this investigation appear to point in that direction, and suggest further enquiry. The subject will receive fuller treatment when these facts are being discussed (*vide* section IX of the report).

REPORT

The Nature of the Work.

I. A census by house to house visitation to ascertain the number of inhabitants alive at each age period within Wuntho town limits, as an index to the effect of malaria upon the public health, and as a mathematical basis for the calculation of vital statistics.

II. Examination of the splenic and endemic indices amongst children as measures of the degree and nature of malarial infection affecting the population at large.

III. The collection (as far as possible bred from larvæ) of specimens of all indigenous anopheles with a study of the bionomics of each.

IV. Addition of type collections to the Provincial Malarial Museum.

V. Dissection and examination of the salivary glands of all anopheles caught in houses and out-houses, with a view to the discovery of those species which might be acting as malarial carriers at Wuntho.

VI. The collection of all statistics, meteorological, vital and medical, available on the spot and from official records, which might possess any bearing upon the problem of local malaria.

VII. An enquiry for comparative purposes into the malarial status of neighbouring villages.

VIII. An enquiry into the parasitology of those parasites found to infest local anopheles.

IX. An attempt by examination of blood smears from all children available below the age of ten years, to ascertain the existence, nature, and degree of prevalence of any unusual hæmosporidia which might own causal connection with endemic blackwater fever.

X. Malarial preventive measures considered as regards Wuntho.

XI. Malarial preventive measures considered as regards the Province in general.

I.—*A census by house to house visitation to ascertain the number of inhabitants alive at each age period within Wuntho town limits, as an index to the effect of malaria upon the public health, and as a mathematical basis for the calculation of vital statistics.*

The following tables exhibit the results of a census taken in October 1912 to ascertain the—

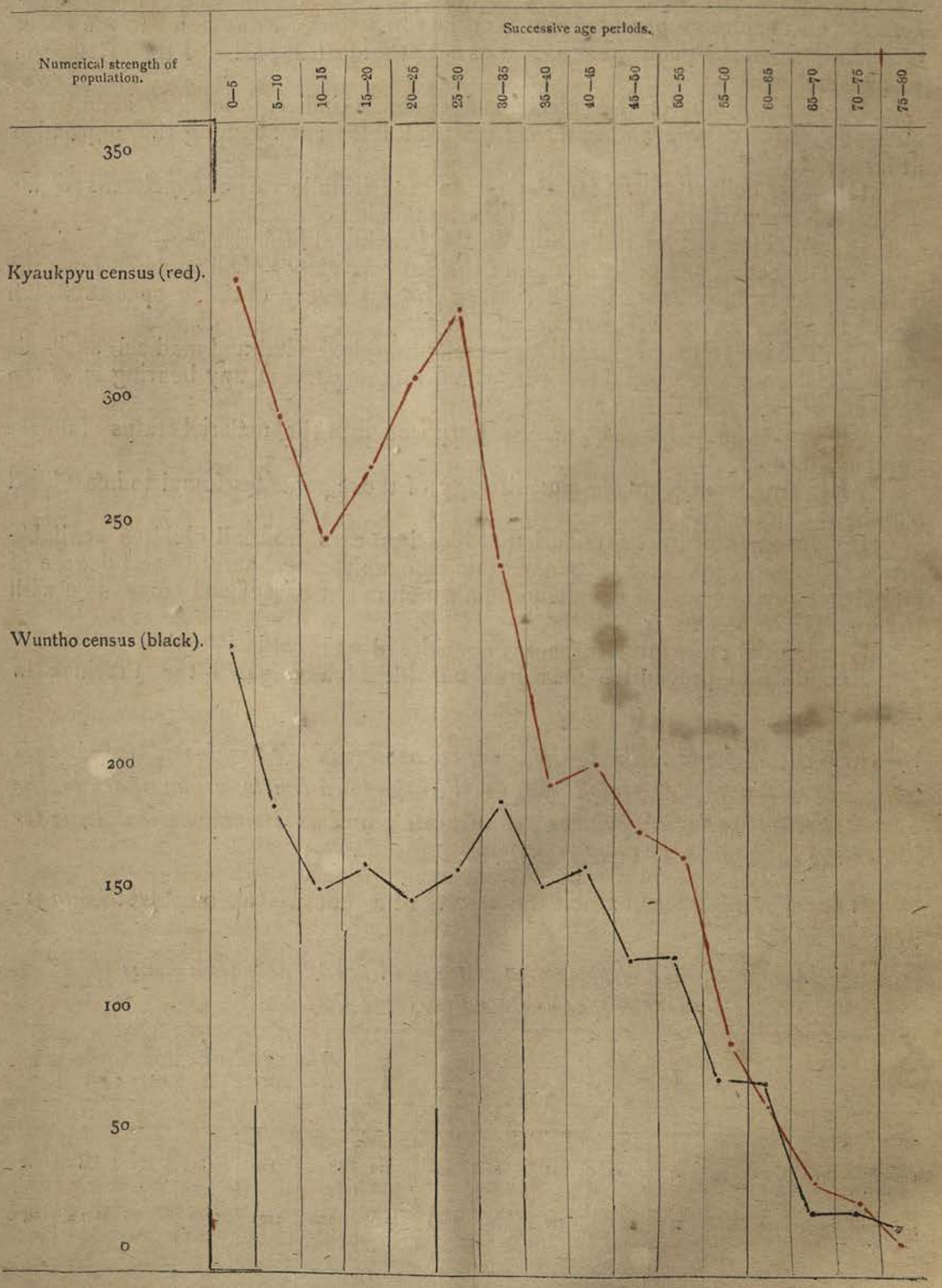
Age constitution of population residing within Wuntho town limits (excluding Military Police and Officials).

—	0—1	1—2	2—3	3—4	4—5	5—10	10—15	15—20	20—25	25—30	30—35	35—40
1	2	3	4	5	6	7	8	9	10	11	12	13
Population alive at each age period.	60	60	44	50	49	176	149	152	132	139	155	125
Mean total of years lived at each age period.	25	75	110	175	220·5	1320	1862·5	2660	2970	3822·5	5687·5	4687·5

—	40—45	45—50	50—55	55—60	60—65	65—70	70—75	75—80	80—85	85—90	90—95	Total.
1	14	15	16	17	18	19	20	21	22	23	24	25
Population alive at each age period.	130	102	105	67	66	21	21	12	5	1	2	1805 population.
Mean total of years lived at each age period.	5525	4845	5512·5	3852·5	4125	1417·5	1522·5	930	412·5	87·5	185	= 51381 years.

Total years lived divided by population $^{51381}/_{1805}$ = 28·49.
The mean age of the living at Wuntho was therefore 28·5 years approximately.

Age constitution of population residing within Wuntho town limits, Katha District, in 1912 *(excluding Military and Civil Lines), as compared with the figures of a similar census at Kyaukpyu in* 1911.



The following explanatory remarks are called for:—

(*a*) The population of Wuntho has been practically stationary since 1901. The census figure in that year was 2296, compared with 2322 in 1911; census figures for preceding decades are not available.

(*b*) The writer's census yields a total population of 1803. This has been checked with the *Thathameda* rolls of the town for 1912-1913, which show the number of persons aged 15 years and over living at Wuntho. The total of such persons as shown in these rolls is 1425, of whom 160 to 200 are stated to be temporary residents. Deducting 180, the mean between these figures, a total of 1245 permanent residents over the age of 15 remains. To this has to be added the number of permanent residents below 15, which according to the writer's age to age census is 568, making a total of 1813; a figure which differs but slightly from that arrived at by the writer.

The explanation of the defect (519) of this figure from that of the 1911 census, lies in the fact, that the 1911 census was taken at a time, when the population was increased by a seasonal influx of inhabitants from surrounding villages for trade purposes.

(*c*) Clerks in Government service, Military Police, and Officials with their families, were excluded from this age to age census; and as there is no Government school, school boys from other places do not enter into calculation.

(*d*) The mean age of the population at death could not be calculated, since registration of births and deaths—apart from the town of Katha itself—has not been extended to the district. The mean age of the living however, agrees, sufficiently closely to render it of some value, with the corresponding figure for Kyaukpyu, which was there to a large extent corroborated by the mean age at death ($\frac{26{\cdot}8}{30}$).

Comparison between the curve for Wuntho, and that for Kyaukpyu, discloses the following features:—

1. Malaria appears to influence general mortality severely up to the age of 25 at Wuntho: to the age of 15 at Kyaukpyu.

2. Alternate elevation and depression at regular five-yearly intervals is exaggerated in the Wuntho curve.

3. From the age of 35 onwards elevation corresponds with elevation and depression with depression in both curves.

4. The greatest difference between the two curves is shown in the age periods 15—20, 20—25, 25—30 and 30—35. The number of persons living at the age period 25—30 in Kyaukpyu is larger than the number of those living at the age period 5—10 (this peculiarity was explained in the writer's report on malaria at Kyaukpyu); the reverse is the case in Wuntho.

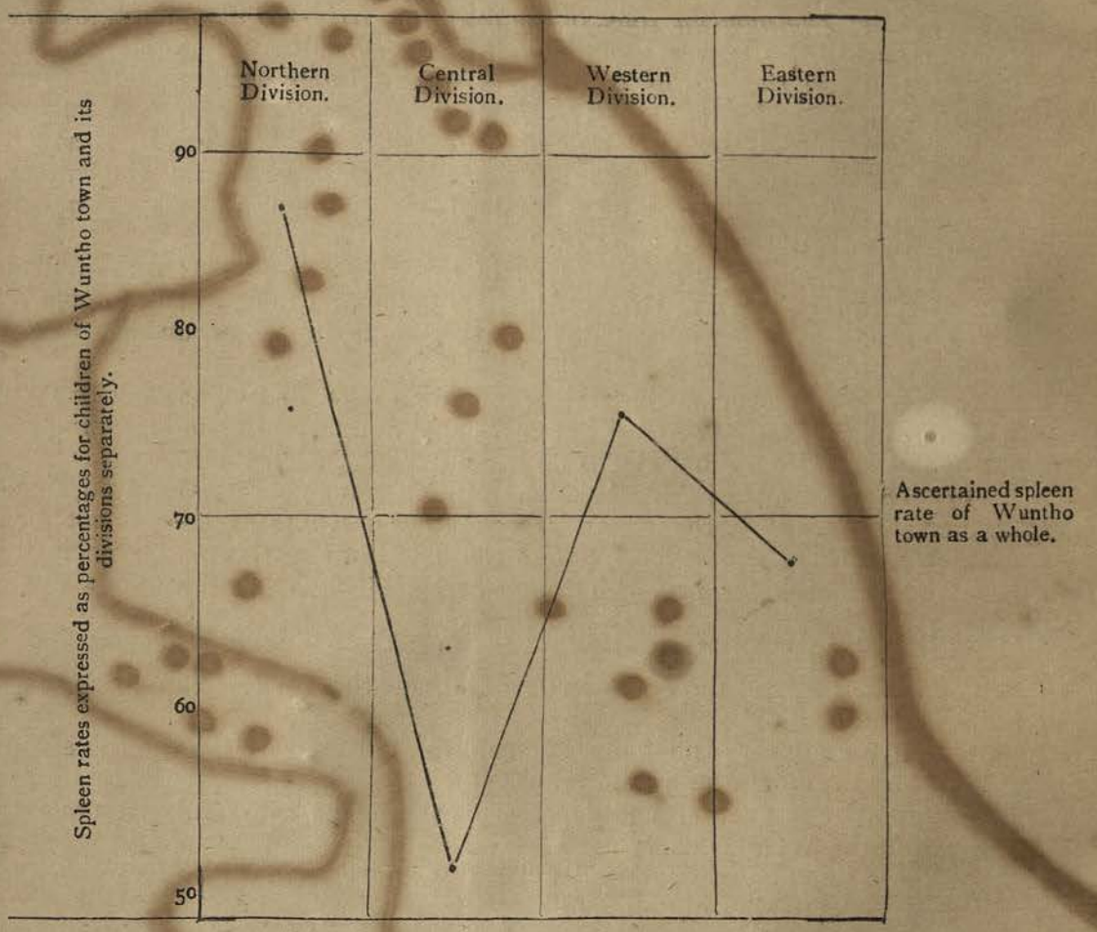
On the whole, if these curves afford trustworthy indication, malaria has been extensively prevalent at Wuntho for a longer period than at Kyaukpyu, and with greater accentuation of its alternate phases of increased and lessened intensity.

II.—*Splenic and Endemic Indices.*

Splenic Indices.—These were taken for Wuntho town and for each of the four villages within a three-mile radius therefrom; the spleen rates and their corrected minima are entered in map No. 1 (Frontispiece). The number of children examined at Wuntho was 207; practically 50 per cent. of those living at the age of 10 years and under (419). As many children at the corresponding ages as could be got together for the purpose, were examined at each village. The corrected minima were worked out after the method described in the writer's report on Kyaukpyu.

The following charts illustrate the results of the Wuntho spleen census :—

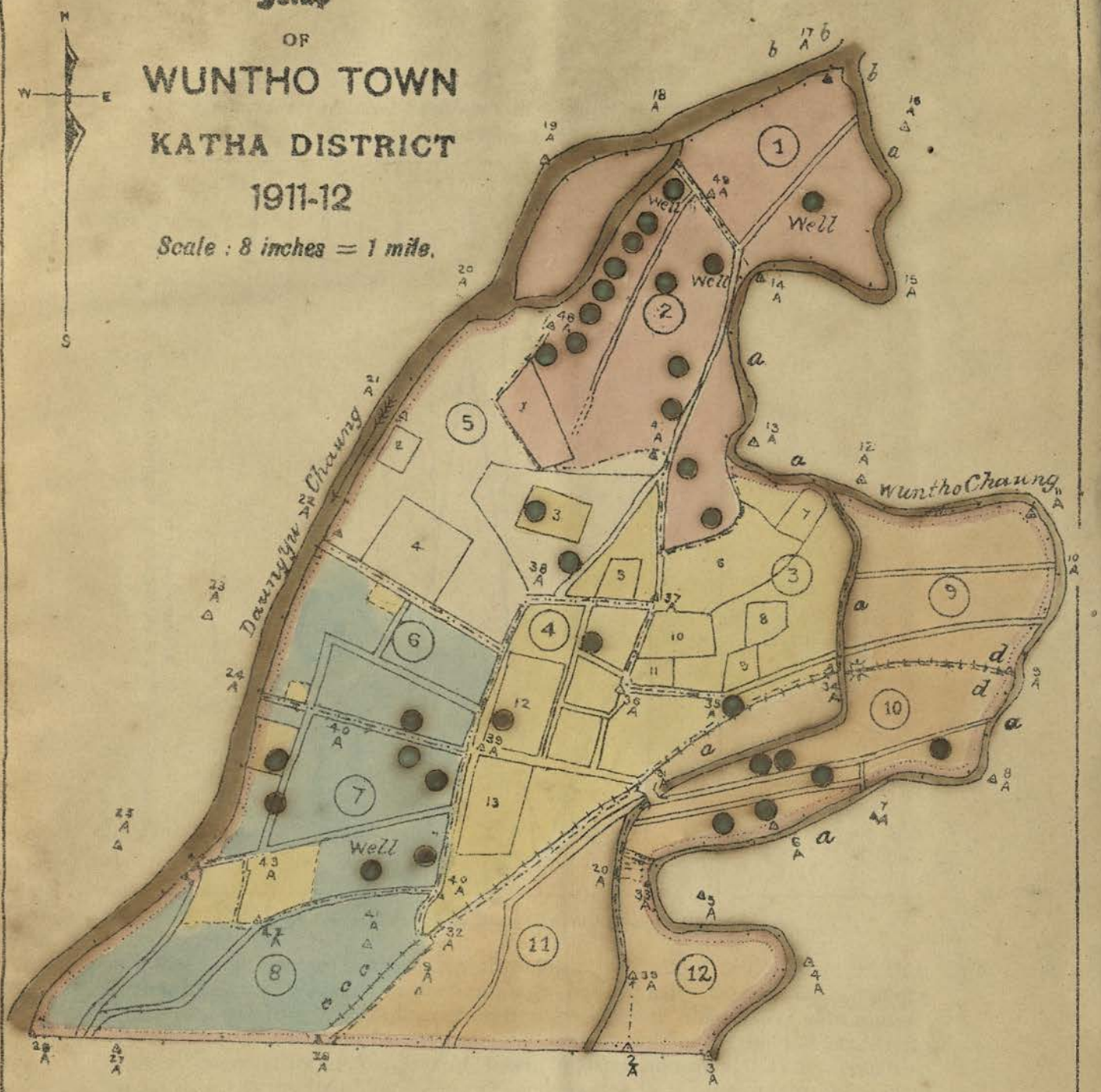
Chart showing the ascertained spleen rate amongst children of ten years of age and under—in each of the four divisions of Wuntho town, compared with that of the town as a whole (*December 11th—17th*, 1912).



The divisions are named in the order in which they appear in map No. 2. The northern is the most severely affected ; then, in descending sequence, the western, eastern, and central.

Map
OF
WUNTHO TOWN
KATHA DISTRICT
1911-12

Scale : 8 inches = 1 mile.



REFERENCES

Northern Division (red)	(1) Sizongon	1 Natkyizin
	(2) Natkyigon	2 Opium Shop
Central Division (yellow)	(3) A-so-ya	3 Hmankyaung
	(4) Myo-Ma	4 Foot-ball ground
(Waste ground)	(5) Hman-kyaung	5 Court-house
Western Division (blue)	(6) Zeanauk	6 Military Police
	(7) Chundaung	7 Bungalow
	(8) Kya-Mainggon	8 Subdivisional Officer's House
Eastern Division (brown)	(9) U-yindaw	9 Forest Office
	(10) Mapegyin	10 Civil Hospital
	(11) Kentha	11 Post Office
	(12) Lebyin	12 Bazaar
		13 Police-station
		Block boundary
		Town boundary
		Railway line

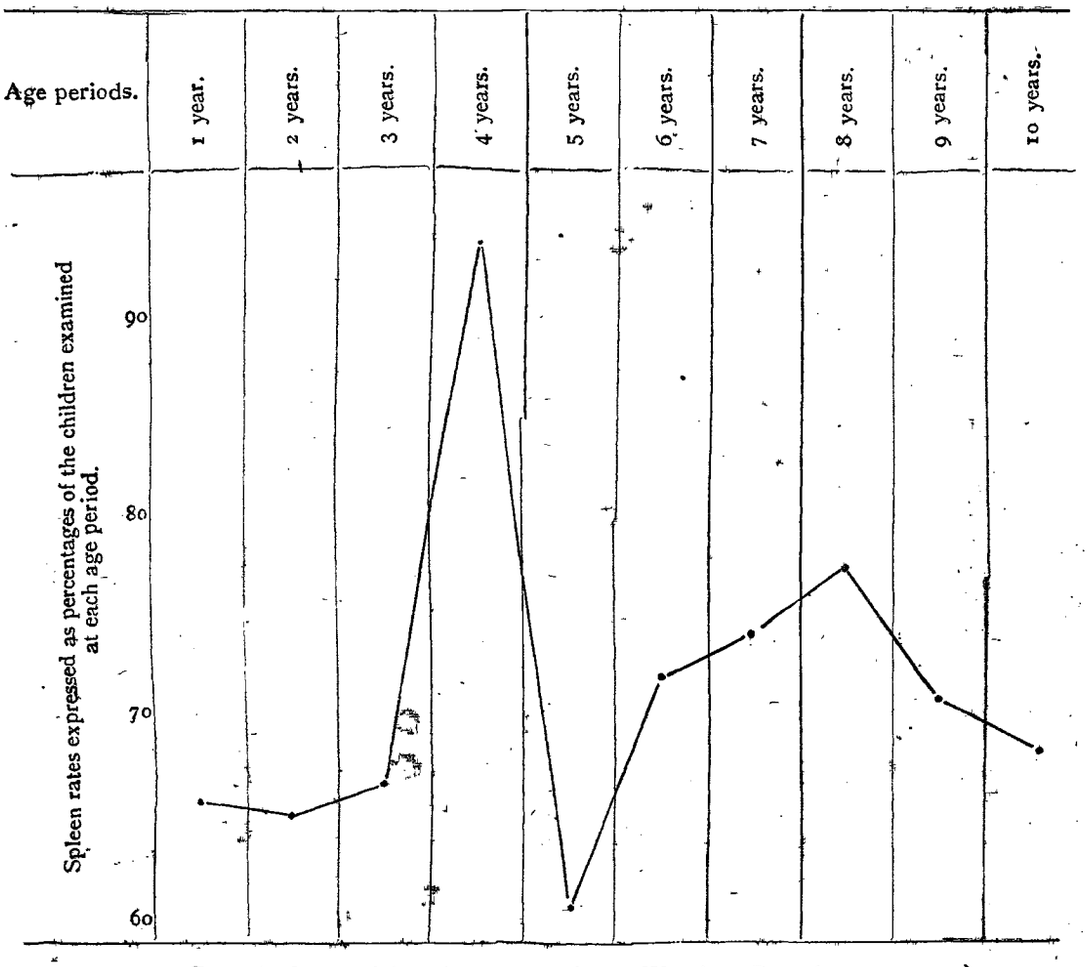
ANOPHELINE BREEDING SITES.

aaa Barbirostris, Culicifacies, Fuliginosus, Listoni v. a., Rossi.
bbb Listoni v. a., Fuliginosus, Maculipalpis.
ccc Culicifacies, Rossi.
ddd Listoni v. a., Fuliginosus, Rossi, Nigerimus.

Office of Superintendent of Land Records, Katha.

G.B.C.P.O.-No 91, I.G.C.H., 25-3-1913. 200.-C. M.

Age incidence of splenic enlargement in children of ten years and under in Wuntho town.



From the figures of the spleen census taken at Wuntho. December 1912.

The results shown in this table are unusual, but there is no doubt of their accuracy. At its lowest, the spleen rate does not fall below 60 per cent. (children of five years), but is extraordinarily high in children of four years, with a corresponding rise in children of eight years. This can only mean that the years 1909 and 1905 were years at Wuntho of severe malarial intensity. That conclusion agrees with the results of local enquiry, and—which is of more importance—with the curve of comparative morbidity from malaria at Wuntho in 1909 shown in chart No. 1.

Such alternate phases of increased and lessened malarial intensity at regular intervals of several years—characteristic of malaria elsewhere, are especially to be remarked in the case of Wuntho.

Twenty-five children of twelve months and under were examined between the 6th and 18th of February 1913 by the writer to ascertain the presence or absence of splenic enlargement. Thirteen of these children or 52 per cent. had enlargement of the spleen. Of eight children twelve months old, six—and of four children less than three months old, one—had splenic enlargement; in this last case of moderate degree (two fingers' breadths below the costal margin).

Of the children found devoid of splenic enlargement on this occasion, the writer re-examined nine on May 26th, and found that one of these—said to have contracted fever towards the close of April—had splenic enlargement of moderate degree.

It appears therefore that unlike Kyaukpyu in 1911-1912—where the fever season was practically confined to the months May to August (inclusive)—the fever season at Wuntho in 1912-1913, extended from the end of April to the end of December.

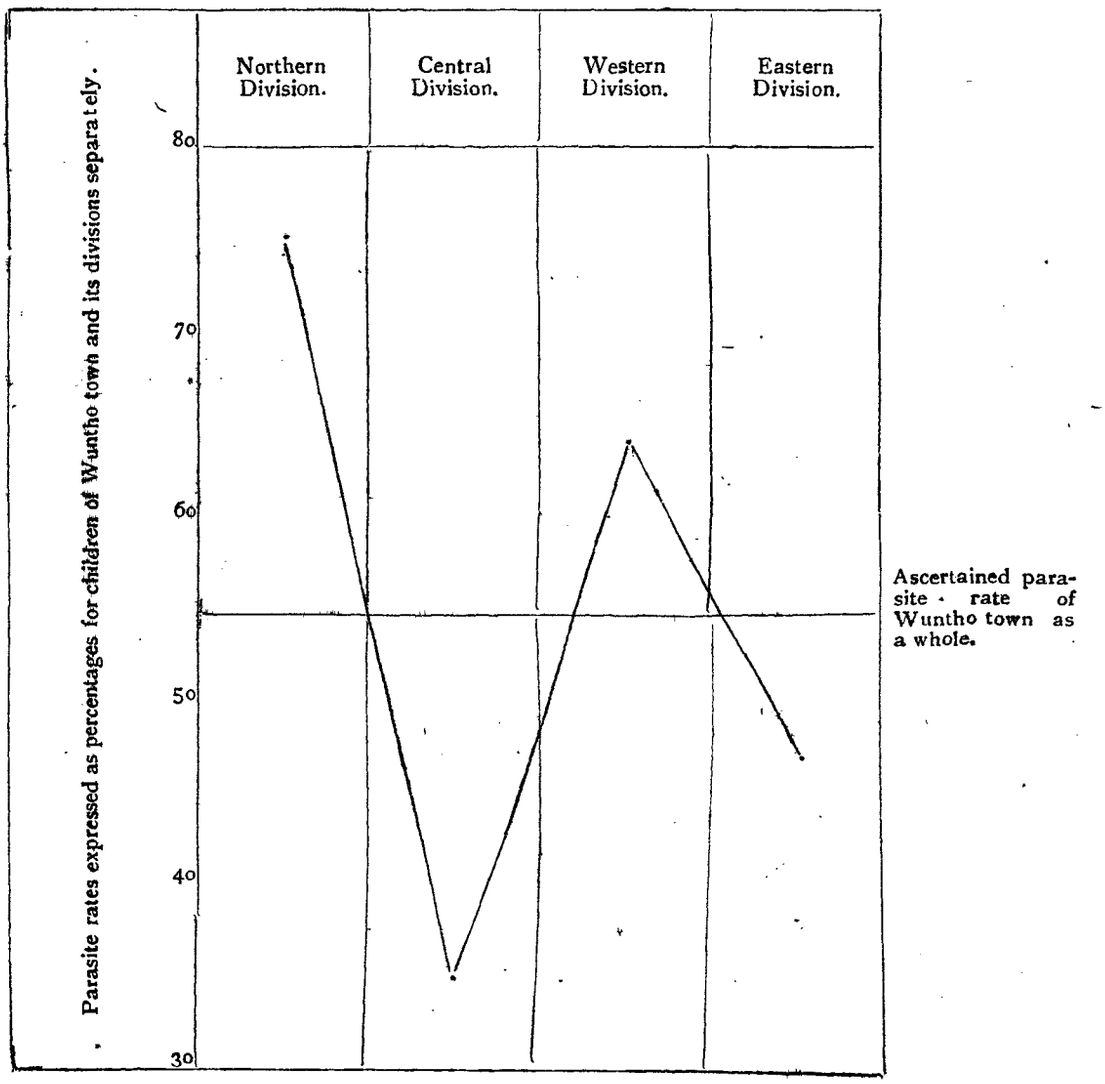
Endemic Indices.—Blood smears were taken from 207 children of ten years and under at Wuntho in December 1912. The following table exhibits the number in whose blood malarial plasmodia were found, with the nature of the plasmodia present :—

Plasmodia found.	No. of children affected.	Total.
Single infections—		
Quartan	21	
Benign Tertian	40	
Subtertian	47	
		120
Double infections—		
Benign Tertian and Subtertian	7	
Benign Tertian and Quartan ...	2	
Subtertian and Quartan ...	3	

The endemic index of the population in December 1912 was therefore 58 per cent. approximately.

The following table exhibits the index thus arrived at for the town as a whole, compared with the corresponding index for each of its four divisions; this table bears comparison with the foregoing table in which the corresponding splenic indices are shown :—

Chart showing the parasite rate in each of the four divisions of Wuntho town in the month of December 1912, *compared with that of the town as a whole.*



In 20 per cent. of children affected gametocytes were found, all three classes of infection being thus represented: subtertian prominently so. But a factor of new significance in this connection was discovered, and is reserved for detailed notice under section IX of this report (*q.v.*).

On the 6th of February the writer took fresh blood smears from sixteen children, blood smears taken previously from whom had revealed certain interesting features.

The spleens of these children re-examined at the same time are classified in the following table:—

Child's name.	Age.	Name of town division where residing.	*Status temporarius* of spleen.		
			Unchanged.	Increase.	Decrease.
Ma Mya ...	3	Central ...	No E.S.	...	...
Mya Me ...	3	Do. ...	...	...	3 F.S. to 2 F.S.
Thein Me ...	5	Do. ...	No E.S.	...	...
Tun Maung ...	2	Western ...	...	No E.S. to 2 F.S.	...
Mi Kway ...	2	Do. ...	3 F.S.	...	...
Tun Ya ...	3	Do. ...	1 F.S.	...	...
Tin Bauk ...	3	Do. ...	3 F.S.	...	...
Ba U ...	3	Do. ...	3 F.S.	...	...
Aung Sein ...	5	Do. ...	4 F.S.	...	...
Aung Mya ...	7	Do. ...	...	2 F.S. to 3 F.S.	...
Sa Le ...	1	Northern ...	3 F.S.	...	...
Thein May ...	2	Do. ...	2 F.S.	...	...
Pin Kain ...	6	Do. ...	Umbilims	...	...
Mi Nee ...	6	Do. ...	...	1 F.S. to 2 F.S.	...
Mi Moo ...	6	Do. ...	4 F.S.	...	...
Tha Han ...	7	Eastern ...	3 F.S.	...	...

III.—The following is a list of all mosquitoes of the genus Anopheles indigenous in Wuntho. The nomenclature is that employed in the latest edition of "The Anopheles Mosquitoes of India," by Majors James and Liston, I.M.S., and the various species found are named in the order of their prevalence:—

Species.	Selective breeding places.
1. Myzorhynchus Barbirostris ...	Old shallow wells—stagnant pools and bays in Wuntho *chaung*—stagnant irrigation cuts littered with debris.
2. Nyssomyzomyia Rossi ...	Shallow pools and stagnant water of cutcha drains.
3. Myzomyia Culicifacies ...	Standing water in Wuntho *chaung*, and drains next railway line.
4. Myzomyia Listoni—Var. Albo-apicalis (Theobald).	Pools in river bed, marshes below railway station, grassy margins upper reaches of Wuntho *chaung*.
5. Nyssorhynchus Fuliginosus ...	Marshes below railway station and grassy pools in river bed at northern end of town.
6. Neocellia Willmori ...	Larvæ not found.
7. Nyssorhynchus Maculipalpis ...	Clear pools in river bed at northern end of town.
8. Myzorhynchus Nigerrimus ...	Marshes below railway station—grassy margins of upper reaches Wuntho *chaung*.
9. Christophersia Halli ...	Larvæ not found.

The species most prevalent in houses and out-houses in the months of the writer's investigation were as follows:—

October.—Barbirostris (very numerous) and Fuliginosus; relative numerical proportion 7 to 2 (Appr.).

Listoni v.a. made its first appearance on October 24th.

December.—Barbirostris (prevalence reduced to one-fourth compared with October) and Listoni v.a.; relative numerical proportion 3 to 2 (Appr.); Fuliginosus also found.

January.—Listoni v.a.; the rest scanty.

February.—Listoni v.a. ; Anopheles scarce generally ; Culicifacies made its first appearance in this month.

May.—Rossi, Culicifacies, and Listoni v.a. ; relative numerical proportions 11 to 10 and 10 to 3—Listoni v a. had practically disappeared by the close of May.

Hence it appears that Listoni v.a, is prevalent from late October to the end of May, Culicifacies from late in February till June, Barbirostris and Fuliginosus from October to December, and Rossi in May. Listoni v.a. alone, was found to act as a carrier.

Barbirostris is by far the most numerous species at Wuntho and its numbers during the single month of October amounted to more than a third of all anopheles found in the course of the investigation.

Of these mosquitoes—Myzomyia Listoni v.a., Myzomyia Culicifacies, and Nyssorhynchus Fuliginosus are recognised malarial carriers. The practical absence of Culicifacies from houses in October and February, and of Fuliginosus in February and May, is worthy of remark ; especially as larvæ of the latter species were found in May, breeding plentifully in pools in the river bed to the north-west, as well as at the grassy margins of the Wuntho *chaung* to the east. The practical absence of Myzorhynchus Barbirostris from houses in February and May is also worthy of remark.

Compared with Kyaukpyu there is a difference in seasonal prevalence of indigenous anopheles. At Kyaukpyu Nyssorhynchus Fuliginosus is prevalent throughout the year, while Wuntho harbours no species of such constant prevalence. The species prevalent during the month of May at Kyaukpyu—*viz.*, Fuliginosus and Ludlowi, and at Wuntho—*viz.*, Listoni v.a. and Culicifacies, are known malarial carriers.

In either locality the writer has found but one species to act as a carrier during that month : Fuliginosus in Kyaukpyu : Listoni v.a. in Wuntho.

The breeding sites of anopheles of local species are indicated upon map No. II.

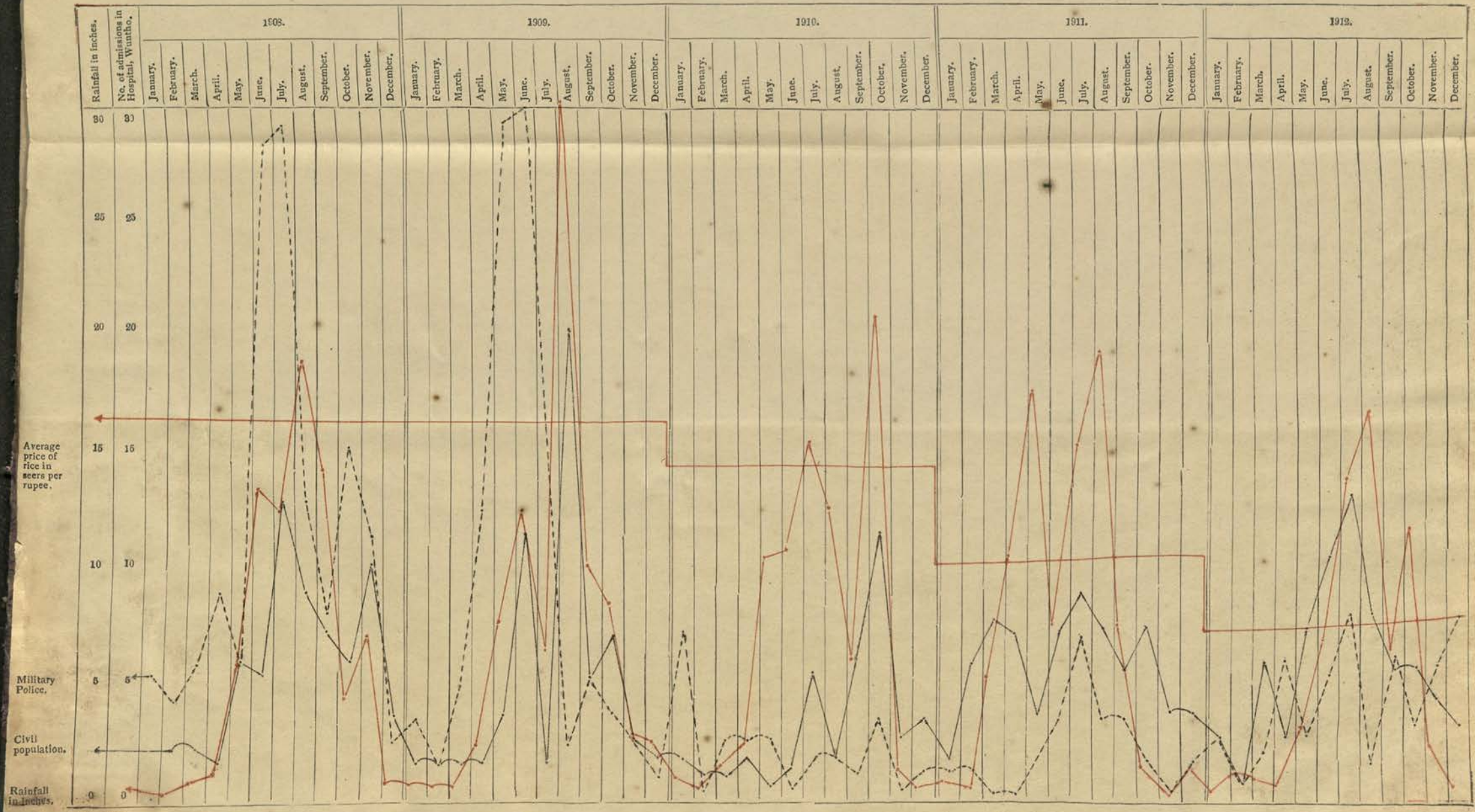
IV.—Specimens of the species numbered 3, 4, 6 and 7 in the table of local species, were added to the type collection of the Provincial Malarial Museum. The rest are already represented.

V.—The following table exhibits the species and numbers of anopheles whose salivary glands were dissected and examined for the presence of malarial sporozoits, together with the dates between which the dissections were performed, and their result :—

Species.	No. dissected.	Dates between which dissected.	Result of dissection.
1. Ms. Barbirostris ...	212	3rd—26th October 1912 ...	Negative as regards sporozoit infestation ; otherwise, *vide* section IX.
	25	6th—16th December 1912 ...	
	2	23rd January—20th February 1913.	
2. Na. Rossi ...	113	16th May—5th June 1913 ...	
3. Ma. Culicifacies ...	2	23rd January—20th February 1913.	
	99	16th May—5th June 1913 ...	
4. Ma. Listoni ...	2	3rd—26th October 1912 ...	Sporozoits in one individual caught on May 20th, 1913.
(Var. Alboapicalis—Theobald)	18	6th—16th December 1912 ...	
	35	23rd January—20th February 1913.	
	26	16th May—5th June 1913 ...	
5. Ns. Fuliginosus ...	61	3rd—26th October 1912 ...	Negative.
	4	6th—16th December 1912 ...	
	1	23rd January—20th February 1913.	
6. Nea. Willmori ..	6	Do.	
	1	16th May—5th June 1913 ...	
7. Ns. Maculipalpis ...	3	23rd January—20th February 1913.	
	1	16th May—5th June 1913 ...	
8. Ms. Nigerrimus ...	2	6th—16th December 1912 ...	
	1	23rd January—20th February 1913.	

CHART NO. I.

Chart showing the number of admissions to hospital at Wuntho for malarial fevers, from amongst the Military Police (dotted curve) and Civil Population (black curve), during each month of the years 1908—1912 inclusive; together with the total rainfall in inches at Wuntho town (red curve) during the months corresponding. The average price of rice in seers per rupee during the years 1908—1912, (inclusive), is also shown (in red).



REMARKS :—

1. The curve of admissions to hospital for the civil population, roughly repeats that of Military Police admissions—at an interval of one to two months. This is probably due to the fact that patients from the civil population usually seek treatment after considerable delay.
2. The strength of the Military Police detachment at Wuntho during the years covered by the chart has varied from 85 in 1908 and 1909, to 79 in 1910, 70 in 1911, and 75 in 1912—*i.e.*, to a minimum equal to 88 per cent. of the maximum. This variation is inadequate to explain that of the curve of admissions from year to year.
3. Malarial morbidity of both Military Police and civil population has corresponded in each year to the height of the rains, and is especially marked at the beginning and close of the latter. The months of May, June and July are the worst, August and September are months of diminished prevalence, while in October malarial fevers undergo a secondary rise.
4. In the year 1911 rainfall in April, May and June was excessive: in 1912 slight. In the years 1908 and 1909 of greater malarial prevalence, rainfall in April, May and June was intermediate in degree. The conditions in 1910 in these months do not materially differ from those of 1909.
5. Fluctuations in the average price of rice do not appear to have influenced the extent of indigenous malaria, or to show any connection therewith.
6. The average monthly wage of agricultural labour was constant. That of coolie labour was higher during the years 1908 and 1909 than in the remaining years covered by the chart.

Of the species represented, all obtainable in October, December, and May, were dissected. The table expresses with a fair degree of accuracy their relative numerical proportion. From the point of view of prevalence five species only enter into consideration as local agents in malarial spread, *viz.*, Barbirostris, Rossi, Culicifacies, Listoni v.a., and Fuliginosus. Of these, the last three are recognised malarial carriers, and one—*viz.*, Listoni v.a.—a definite local carrier; in the salivary glands of the first, resistant spores or cysts of peculiar nature, have been found. The fact will be again referred to under section IX of this report.

VI.—Registration of vital statistics is not in force in Katha District outside the limits of Katha town, and hence statistics based upon birth and death rate are not available for Wuntho. Maximum and minimum variations of the daily atmospheric temperature are not recorded at Wuntho, and no information other than the scanty details afforded in the introduction is available in this connection. The statistics collected at Wuntho have therefore been confined to those which concern—

(1) Monthly rainfall in inches.

(2) Morbidity from malaria amongst men of the Military Police, and in the civil population—as gathered from the registers of the local hospital.

(3) Yearly variations in the average local price of rice.

(4) Yearly variations in the average wage of unskilled labour (including rough carpentry and blacksmith work).

(5) Monthly variations in the local sale of Government quinine.

There is no local jail, the only available and collected statistics under this head being those of the district jail situated at headquarters, in Katha itself. These latter, which merely support other evidence of the slight extent to which Katha town is affected by malaria, afford no conclusions at all applicable to Wuntho, and are not quoted.

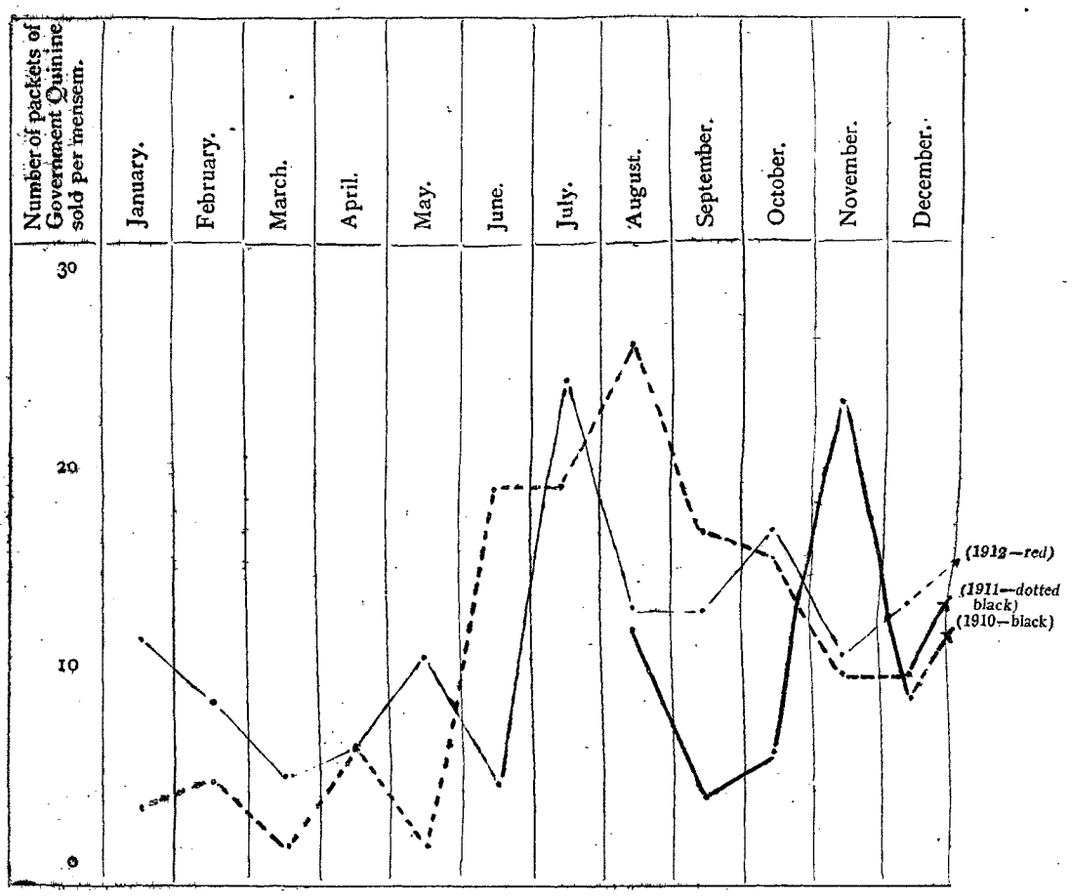
As regards the statistics numbered in the list, those under the first three heads are compared in the accompanying chart, the explanations and remarks appropriate to which are entered upon the chart itself.

Those collected under the last two heads are exhibited in the following tables:—

Wages and average retail prices at Wuntho for the years 1908 *to* 1912 (*inclusive*).

Year.	Average monthly wage				Cart hire per day.	Average retail prices in seers per rupee.					Remarks.
	Of able-bodied agricultural labourer.	Of coolie.	Of carpenter.	Of blacksmith.		Rice.	Jowar.	Salt.	Jaggery.	Fish.	
1	2	3	4	5	6	7	8	9	10	11	12
	Rs.	Rs. A. P.	Rs.	Rs.	Rs. A. P.	Rs.	Rs.	Rs.	Rs.	Rs.	
1908	15	30 0 0	28	20	1 0 0	16	...	14	...	4	The average monthly wage of able-bodied agricultural labour compares seriously with the average retail price of rice for 1911 and 1912 in seers per rupee. In so severely stricken a malarial centre as this a sliding wage based on the average retail price of rice is advisable from a public health standpoint.
1909	15	30 0 0	28	20	1 0 0	16	...	14	...	4	
1910	15	22 8 0	32	25	1 8 0	14	...	14	...	3	
1911	15	22 8 0	32	25	1 8 0	10	...	14	...	3	
1912	15	22 8 0	32	25	1 8 0	7	...	14	...	3	

Number of packets of Government quinine sold by the Wuntho Treasury monthly fr[om] August 1910 *(when the sale commenced) to the close of the year* 1912.



This table exhibits the number of packets sold, not alone to residents, but to incomers from surrounding villages as well. The amount of quinine hitherto consumed by the latter is slight, and probably three-fourths of the above quantities were consumed in the town. In any case it is the *monthly variation* in the sales which is of importance, since that helps to locate the fever season. June, July, August, October and November appear to have been the months of greatest prevalence. This conclusion is supported on the whole, by the hospital figures of variation in morbidity from malaria shown in chart No. I.

VII.—*An enquiry for comparative purposes into the malarial status of neighbouring villages.*

Four villages within a three-mile radius of Wuntho were visited to ascertain the spleen rate amongst children of ten years and under. These villages are shown on map No. 1 (Frontispiece) and the ascertained spleen rate of each is entered beside its name with the corrected minimum in brackets.

These spleen rates and their corrected minima were as follows :—

Myaukle	...	Spleen rate	66·6	per cent.	Corrected minimum	44	per cent.
Kyidaing	...	Do.	95·2	„	Do.	89·4	„
Kyauklaing	...	Do.	85·7	„	Do.	66·7	„
Letpangyin	...	Do.	86·6	„	Do.	66·3	„

Thus, the last two named exhibit a corrected spleen rate which is closely comparable with that of Wuntho, while the first on the list has a distinctly lower, and the second a distinctly higher, corrected spleen rate. If it be assumed in the case of these two latter villages that the corrected figures exaggerate the truth, it is still just to conclude that Myaukle village is less, and Kyidaing village more, affected by malaria than Wuntho.

Anopheles found during May in houses and out-houses of Kyidaing village proved to be of the same species and relative prevalence as those found in the same month at Wuntho, *viz.*, Rossi, Culicifacies, and Listoni v.a.

Fever is said to prevail at these villages in the same months as at Wuntho. At Letpangyin village a child born in the first half of December 1912 was found to present splenic enlargement of moderate degree during the month

of February. This establishes a presumption that infection had been contracted during the latter half of December.

The writer visited Kawlin, a town on the railway below Wuntho and some six or seven miles from the latter, during October 1912. Besides Barbirostris and Fuliginosus—the only anopheles present in houses in Wuntho at that time—a few individuals of the species Nigerrimus and Rossi were discovered locally. As in the case of Wuntho, Barbirostris abounded : to an extent seven times greater than that of the three remaining species taken together. The salivary glands of 49 Barbirostris caught at Kawlin were broken in normal saline, and stained and examined for sporozoit infestation with a negative result. A sample anopheles catch was taken in the town of Mohnyin at the beginning of February 1913, and proved to resemble catches during the same month at Wuntho, as regards species and comparative numerical prevalence. Barbirostris however—then absent at Wuntho—was found at Mohnyin.

The conclusions to be derived from these observations are :—

1. That malaria prevails throughout the valley in which Wuntho lies.

2. That anopheles of the same species and the same relative prevalence are to be found in places in the district as far apart as Wuntho, Kawlin, and Mohnyin.

3. That Myzorhynchus Barbirostris attains a degree of general prevalence late in the rains which is very great, and—in the writer's experience—very unusual elsewhere.

VIII.—*An enquiry into the parasitology of those parasites found to infest local anopheles.*

The Provincial Malarial Committee at its fourth meeting on July 1st, 1912, recommended that the Special Malarial Officer, in conducting malarial investigations at a suitable centre in Katha District, should in the course thereof ascertain the extent to which malaria-carrying anopheles are infested by the fly called " Ceratopogon Ferox, " and the acarine mite—mentioned in the Kyaukpyu report ; also that he should endeavour to determine the influence exercised by each of these parasites, upon the malaria-bearing capacity of anopheles carriers, and in exterminating the latter (*vide* Proceedings of the fourth meeting of the Provincial Malarial Committee, minute 2, paragraphs *b* and *c*).

In accordance with this programme the writer endeavoured at Wuntho to ascertain as much as possible with regard to the prevalence (or otherwise), and habits, of the fly and mite.

The results of this part of the investigation are as follows :—

The fly was found to be present at Wuntho during the late rains (October) but not subsequently ; not at all events between December and June. It was not observed in any instance to infest caught anopheles of local species and this—in view of its tenacious habits—seems to indicate that local anopheles are immune from infestation.

It does not therefore play at Wuntho the rôle it appears to play at Kyaukpyu.

The acarine mite found at Kyaukpyu was not found at Wuntho, but a mite of the same family and the same parasitic proclivities was found to infest Myzorhynchus Barbirostris and Nyssorhynchus Fuliginosus at the latter centre. This mite appeared more active and more numerous upon a single host than that discovered at Kyaukpyu. The writer found as many as 25 upon a single Barbirostris, and these attacked not alone the neck and thorax of the mosquito, but the abdomen as well. Specimens detached and placed in water were able to swim about actively. Evidently the mite can live in water, and is to that extent aquatic. It appears to pass the whole of its larval existence upon adult anopheles. Very young specimens were found by the writer, as well as older ones. All on the same host, however, appeared to be of equal development. This renders it likely that they are carried by the mosquito from the time of its birth as an imago. They have never been seen by the writer upon the larva.

The description of the gamasid mite found at Kyaukpyu applies also to that found at Wuntho, with the following differences :—

The Wuntho mite is, as soon as it has attained any size, of a brick-red colour; the colour of the Kyaukpyu mite is not obvious to the naked eye. Under the microscope the dorsal shield of the Wuntho mite, in place of the blue and pink pattern observable in the case of the Kyaukpyu mite, is of a uniform reddish colour; whilst in place of being smooth and structureless as in the case of the Kyaukpyu mite, the dorsal shield consists of overlapping elliptical plates in appearance not unlike scale armour. At the junction of these plates and at regular intervals, are situated sessile elevations from each of which projects a single fine hair. The reddish colouring matter is contained in small pits in the plates of which the shield is composed, and appears to be soluble in alcohol, which discharged the red colour when the mite, in course of mounting permanent specimens, was dehydrated in that medium.

The accompanying illustration gives some idea of the dorsal aspect of this mite under low magnification. It should be added that hairs similar to those on the dorsal aspect are equally numerous upon the ventral. The interesting fact about this mite is—that its nymphal and adult stages appear to be passed upon a small fly of the family *Psychodidæ*. The large illustration is from a free hand drawing of a specimen in the writer's possession, which shows the adult mite in position upon the fly (Leitz obj. 3, ocular 4). The fly has taken a meal of human blood (from the writer who subsequently caught it) and the mite may be observed to have ingested the sanguineous contents of one of the intestinal diverticula. This is very clear in the specimen, though not well shown in the drawing. The nymph, which the writer has seen on this fly, is of the same red colour as the larva, and the dorsal shield—the plates of which are now large and distinct—seems to cover the dorsum. Though the adult fades to a brownish colour, the plates of the dorsal shield are clear—as also sessile elevations and hairs like those found upon the larva.

Identity in species between the larva found on the mosquito and the adult found on the psychodid fly, is inferred by the writer from the occurrence of both in the same locality at the same time, and from the structural resemblance between the rudimentary dorsal shield of the larva, and the complete dorsal shield of the adult. Neither mosquito—with larval mite, nor psychodid fly—with adult, were discoverable at Wuntho after October, and further investigation and collection of specimens were thus unfortunately impossible.

The question of identity of species, though such is probable, must remain open for the present. If such identity is established the fact is of interest—since it demonstrates an indirect mode of communication between human blood and the anopheles mosquito, *viâ* the psychodid fly, the adult mite, and the ovum and larva of the latter. The observed infestation rate of the psychodid fly by the adult mite in October 1912, was 4 per cent.

IX.—*An attempt, by examination of blood smears from all children available below the age of ten years, to ascertain the existence and degree of prevalence of any unusual hæmosporidia which might own causal connection with Blackwater Fever.*

Prior to the commencement of this part of the investigation the writer had formulated certain definite views with regard to the ætiology of Blackwater Fever. These views were appended to a preliminary account (after the narrative of Dr. L. G. Fink) of Blackwater Fever in Burma; published as part of the Spleen Census Report of the Province, during the month of September 1912. They are here reproduced :—

1. As far as its effect upon, and contribution to, general mortality is concerned, Blackwater Fever is relatively unimportant.

2. Its importance lies in its significance as a cause of death in individual cases. Mortality in cases of Blackwater Fever is unquestionably high.

3. Otherwise the disease, being a sequela of malaria, must disappear with the disappearance of malaria itself.

AN UNUSUAL TYPE OF MALARIAL INFECTION

Fig. 1

Gamasid mite, found to infest certain anopheles at Wuntho—dorsal aspect.
(Leitz—obj. 3, oc. IV)

Fig. 2

Psychodid fly infested by adult Gamasid mite.
(Leitz—obj. 3, oc. IV.)

4. The researches of Christophers and Bentley go far to establish the view that the disease is due to an auto-hæmolysis sequent upon severe malaria.

5. It is likely that denizens of malarial tracts are less prone to succumb to Blackwater Fever than are new-comers—such as Europeans and Government Officials.

6. Individual prophylaxis in malarial areas is calculated to prevent malarial fever and, *pro tanto*, Blackwater Fever also.

These views again met with expression on the part of the writer at Madras in November 1912*; subject, as regarded the conclusions arrived at by Major Christophers and Dr. Bentley, to the reservation—that certain observed peculiarities in the geographical distribution of Blackwater Fever had not been satisfactorily accounted for.

Facts to the logic of which the writer would invite attention are :—

1. The association of Blackwater Fever with definite areas which, with insignificant exceptions, are areas in which malaria of a severe type is also prevalent.

2. The rarity of Blackwater Fever, even in areas where it is indigenous; a rarity which conflicts with any theory based upon the supposition that it is—whether zymotic, or due to parasitic protozoa—a separate and communicable disease. Blackwater Fever is indigenous in Katha District at certain centres, of which the chief are Mohnyin and Wuntho.

The following table shows the cases recorded as having been treated at the Wuntho Civil Hospital in the years 1910 and 1912; two died and four recovered. No cases are recorded for the years preceding.

Statement showing admissions of Black-water Fever cases, Wuntho.

Number of case.	Name.	Age in years.	Class.	Date of admission.	Recovered.	Died.	Remarks.
	Civil Population.						
	1910.						
1	Ko Sai Chai ...	25	Chinese ...	8th September 1910.	13th September 1910.	...	
	1911.						
	Nil.						
	1912.						
1	Rangasamy Iyer	24	Hindu ...	15th June 1912	20th June 1912	...	
2	Maung Ba Lwin	32	Burmese ...	12th October 1912.	19th October 1912.	...	
3	Aimu Kaka ...	22	Mohamadan	10th November 1912.	19th November 1912.	...	
	Military Police.						
	1910.						
1	Budhev Singh ...	37	Hindu ...	21st September 1910.	...	24th September 1910.	
	1911.						
	Nil.						
	1912.						
1	Abdul Karin Khan	22	Mohamedan	14th October 1912.	...	15th October 1912.	

Judging from the date of onset of the symptom in these cases, risk of Blackwater Fever at Wuntho seems to have been greatest in the months of September and October. It is worthy of remark that no cases were treated at the Civil Hospital during the year 1911.

* *Vide* page 19 of the Proceedings of the Third Meeting of the General Malarial Committee held at Madras, November 1912.

In blood smears taken from over 200 children of ten years and under at Wuntho in the month of December 1912, malarial plasmodia of the usual three types—Subtertian, Benign Tertian, and Quartan—were encountered, and so far the picture was simply that presented by any other severely stricken malarial community.

In some fourteen instances, however, other plasmodia of malignant character were found, alone or in combination with the preceding; and their presence was found associated with unusual appearances of a remarkable kind, in the blood smear (Leishman's stain). These latter were partly indeterminate and partly determinate. They are summarised respectively as follows:—

Indeterminate.

1. Large mononuclear cells, apparently of endothelial origin. These were of flat leaf-like appearance. Their nuclei stained deep purple red: their cytoplasm—which was coarse and reticular—blue or pinkish, sometimes taking one or other of these stains so faintly as to be visible with difficulty. On closer examination it appeared that the deep purple red of the nucleus was not due to the colour of the nucleus itself, but to an accretion of chromatic material which—superimposed upon, and glued as it were to, the nucleus—deepened its stained appearance, sometimes extended beyond its margin, and sometimes—where the reverse condition was found—allowed the natural tint of the nucleus to be seen beyond it. In some cells this accretion appeared to have stripped off, leaving the marks of its original limits with one or two deeply staining remnants behind.

2. Vestigia of the preceding cells, staining a faint pink but retaining clearly the outline of the original nucleus and cytoplasm.

3. Smaller cells the nuclei of which exhibited a deeply stained purple appearance, but the cytoplasm of which, though coarsely reticular, stained a uniform deep blue.

4. Amorphous bodies—apparently of discarded chromatic accretion—staining a deep red, and of the size, more or less, of mononuclear nuclei.

5. Oval bodies of opaque purple colour and regular outline which were not nuclei of normoblasts (normoblasts were not observed) and resembled spores.

6. Polynuclear leucocytes, in the nuclei of which were large granules of a deeply staining purple.

7. Polychromatophilic erythrocytes.

8. Erythrocytes with basophilic granulation; these were observed in two specimens only.

Determinate (vide *coloured illustrations*).

1. Certain initial spores (Fig. 2), cytoplasm blue with bluish stippling and a round mass of chromatin, which appeared later to have resolved into three or four chromatin rods surrounded by a vacuolic area. In a single instance the writer observed one of these spores occupying a red corpuscle (Fig. 3). Each spore is primarily contained in a darkly staining blue envelope; in Fig. 3 the spore is clearly seen to have lost this.

History.

These spores, losing their envelopes, enter, or are taken up by, mononuclear cells of types 1 and 3 (*vide supra*). Each becomes incorporated with and grows in the nucleus of its host, protected and covered in by accretions of nuclear material derived from nuclei of broken down white cells. Growth proceeds to a point when the nucleus is seen to be occupied by six double spores arranged *en rosette;* each pair contained in a reddish purple staining envelope derived from the nuclear accretion (*vide* Fig. 4). The union between the initial spore and its cell host during these changes does not appear to be a very close one. Appearances suggest that the daughter spores sometimes break away from the nucleus of the first cell host to be taken up by another of the same kind, or by

Illustrations from freehand drawings of the original specimens (Leitz—obj. $\frac{1}{12}$a. oc IV—Leishman's stain).

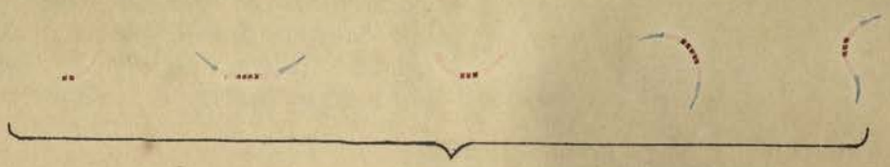


Fig. 1

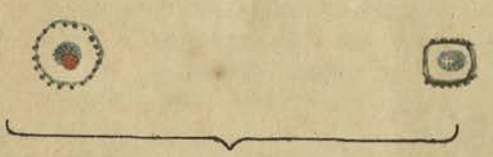


Fig. 2

Fig. 3

Fig. 4

Fig. 5

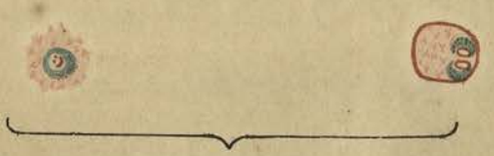


Fig. 6

Fig. 7

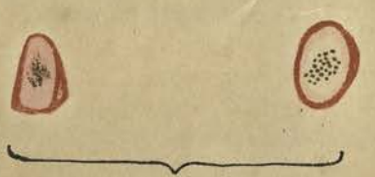


Fig. 8

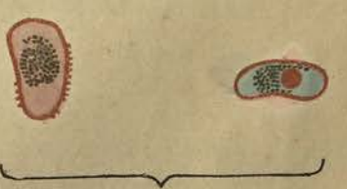


Fig. 9

C. Parthsarathy del.

G. B. C. P. O.—No. 31, I. G. C. H. 11-10-1913—180. L.

a polynuclear white cell; in the nucleus of which, having taken up a position, they cause the cell to assume the appearance described as type 6 (*vide supra*).

2. Associated malarial plasmodia of extreme malignancy (Figs. 5 and 6), all forms of which have been seen in blood smears.

3. Male and female crescents and ovoids, each of which is seen to be surrounded by the chromatic envelope of the spore from which it was derived (Figs. 7, 8, and 9).

As these crescents are plainly derived from chromatic spores free in the blood (type 5, *supra*), the genesis of which (Fig. 4) has been observed therein, it seems legitimate to conclude that other spores of the same kind, in place of becoming crescents, enter into red cells and develop into schizonts. The writer has actually observed the process, but the specimen illustrating it has unfortunately faded to such a degree, owing to effects of climate, as to be useless for demonstration purposes.

The red cell was seen to contain a large circular spore, the envelope of which was thick, and stained a decided red. Inside the envelope the spore could be seen to have divided into twelve pinkish masses of the colour of the cytoplasm in Figs. 7 and 8.*

That Figs. 2 to 9 represent successive stages in the life history of a definite and single type of malarial plasmodium, the writer—on the ground of their frequent association—considers highly probable. The enormous destruction of mononuclear endothelioid cells for which—with perhaps other destructive properties as regards the white cells of the blood—this type of malarial infection is responsible, might possibly cause the auto-hæmolysis, to which, in the opinion of Major Christophers and Dr. Bentley, Blackwater Fever is due. It is worth while observing here that moderate pressure upon the ball of the finger in taking blood specimens from some of these children was productive of a purplish subcutaneous bruising.

The mode of malarial infection described, appears, geographically speaking, to be as exceptional as Blackwater Fever itself; certainly the writer has not observed it elsewhere.

As regards the probable infecting agency the writer can only state:—

1. That Myzorhynchus Barbirostris is of extraordinary and unusual prevalence both at Wuntho and Mohnyin, in the month of October.

2. That spores similar to these sketched in Fig. 2 have been seen in stained specimens of the salivary glands of that mosquito during the same month, together with certain spore-bearing cysts of dark purple colour (Leishman's stain).

3. That spores similar to those sketched in Fig. 2 have recently been found by the writer (June 18th) in the salivary glands of two local anopheles of known malaria-carrying species, *viz*:—Myzomyia Culicifacies and Myzomyia Listoni v. Alboapicalis (Theobald).

The sporozoits shown in Fig. 1 were found in the salivary glands of an individual *Myzomyia Listoni—Var. Alboapicalis* (*Theobald*) during the month of May. It is possible that sporozoits similar to these (which present some unusual features) may represent the initial infective stage of anopheles from humanly derived plasmodia of the above origin.

If it is asked from what source these anopheles obtained the primary spores, it may be replied that Myzorhynchus Barbirostris—a wild anopheles—may have generalised the spores from a primary source—animal or vegetable—connected with stagnant water, and decaying vegetation.

NOTE.—Appearances of an indeterminate character similar to those above described with regard to human blood, have been observed by the writer in the blood of frogs caught at Wuntho. These appearances were associated with the presence of a hæmosporidium.

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* The writer is not satisfied that the spore seen in this stage was really that of the plasmodium under discussion. Certain appearances of another kind, which pointed to an *ab initio* development of the human plasmodia of benign Tertian and Quartan fevers, were observable in some of these specimens, and this stage may have belonged to one or other.

The doubt, however, does not affect the developmental history given; since the fact that this stage—a necessary one in evolution—occurs in the case of one type of plasmodium, is sufficient to show that it must also occur in the case of the others.

If this suggestion be true, we are placed in a position to account satisfactorily for one feature of malaria and for another of Blackwater Fever, explanation of which—based on present knowledge—does not carry complete conviction.

These features are as follows :—

1. The experience—undeniable in Burma—that a human being may, in the course of exploration of dense jungle tracts uninhabited by man, contract malarial fever of a most malignant type—which from the nature of the circumstances can scarcely have been derived by the infecting mosquito from the blood of man.

2. The fact that Blackwater Fever has—in one or two rare instances cited in the literature of the subject—been reported from places where malaria exhibited no endemicity.

The presence in such an area of Myzorhynchus Barbirostris in moderate numbers—if one or two were carriers from a primary source—might result in a case of human infection, which absence or scarcity of other species of anopheles in the locality might save from translation into terms of general malarial prevalence.

The fact that repeated attacks of malarial fever—insufficiently combatted by quinine—in subjects whose malaria was contracted in a Blackwater Fever area, sometimes culminate in the latter symptom, may be otherwise accounted for.*

It will not be out of place to recall here certain anticipations expressed by Professor E. A. Minchin, M.A., which are embodied in the following extract† :—

"The number of instances in which intermediate hosts have been demonstrated for Hæmosporidia has been increased so steadily by recent researches that many authorities are inclined to the belief, to which expression has recently been given by Börner, that for all species of Hæmosporidia there is some blood-sucking animal which is the agent in the dissemination of the parasites, and that where no intermediate host is known, it merely remains to be discovered.

"There are, however, many grounds against believing that an intermediate host occurs in all cases. First, on general grounds, if the modern conception of the Hæmosporidia as forms closely allied to Coccidia, adapted to parasitism upon blood-cells, be correct, it is reasonable to suppose that the ancestors, at least, of the group under consideration were at first without any special means of dissemination other than the resistent spores and cysts found in Coccidia and Sporozoa generally; and if this be admitted, it becomes further highly probable that representatives of these primitive forms will be found to exist at the present day. * * * * * * * * * "There is therefore a very strong case in favour of the view expressed by Schaudinn, namely, that many Hæmosporidia, especially those of cold-blooded Vertebrata, are not disseminated by an intermediate host, but that the infection is a casual one, as in any other kind of Sporozoa. It is evident that the acquisition of an intermediate host is an adaptation which is vastly beneficial from the point of view of the parasite, as is shown by the rapidity with which the diseases caused by them spread in countries where the two necessary conditions occur—the presence, that is to say, both of the parasite and of its blood-sucking intermediate host. The latter in all cases hitherto investigated has turned out to be an Arthropod, within which the sporogony of the parasite takes place, and upon which the oöcysts are actively parasitic. A general survey of the life-cycles of Hæmosporidia and Coccidia would lead one, however, to believe that primitively the sporulating stages would not have been parasitic upon the intermediate host, but that the latter would have acted merely as a carrier and not as a host, in the strict sense of the word. A life-cycle of this kind remains as yet hypothetical, but may be postulated as a stage in the evolution of the adaptive relation between parasite and blood-sucker, even if non-existent at the present day."

Summarised as regards malaria at Wuntho the facts are as follows :—

(*a*) Malaria at Wuntho is severe, general, and associated with Blackwater Fever.

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* For the writer's explanation of the action of quinine in contributing to such a result, *vide* Proceedings, 3rd meeting, Central Malarial Committee, Madras, November 1912. pages 19 and 20.

† Treatise on Zoology, edited by Professor Ray Lankester, M.A., LL.D., F.R.S.—Part I, Second Fascicle Sporozoa, pages 263 and 264.

(*b*) The Anopheline fauna of Wuntho differ from those found by the writer elsewhere, in the enormous prevalence of the wild species Anopheles Barbirostris.

(*c*) A primitive and exceptional mode of malarial infection hitherto undescribed has been found amongst children below the age of ten years, and appears to be communicated by Myzomyia Culicifacies, Myzomyia Listoni v.a., and Myzorhynchus Barbirostris—especially in the month of October by the last named.

(*d*) Of other anopheles found prevalent at Wuntho three are recognised malarial carriers elsewhere, *viz.*, *Listoni* (*Var. Alboapicalis—Theobald*), *Culicifacies*, and *Fuliginosus*.

X.—*Malarial preventive measures considered as regards Wuntho.*

It is a peculiarity of Wuntho that the great majority of the breeding places of local anopheles either lie within, or closely surround, the town itself. The Wuntho *chaung* and its branches—irritation cuts with which the few marshes within town limits are connected—form permanent sites for anopheles breeding of greater importance than all the rest put together. If these sites could be eliminated for two months in the year, it is certain that the prevalence of all anopheles at Wuntho—and especially of Myzorhynchus Barbirostris and Myzomyia Culicifacies—would be very largely reduced. The following recommendations appear to be practicable, advisable, and inexpensive :—

1. The cutting down and burning of all jungle, for a radius of one mile around Wuntho town and each of its neighbouring villages, every year at the beginning and close of the dry season, with the object of destroying as many as possible of the adult anopheles then prevalent; thus limiting their subsequent extension in the rains.

2. The drying up of the Wuntho *chaung* and its branches as early as possible after the close of the rains (by shutting it off from the Daingyu *chaung* all through the cold and dry seasons).

3. Treatment—with the author's larvicide *—of all stagnant collections which exist in the cold season and dry weather (these are few).

4. Regular clearing from grass and weeds of the margins of the Wuntho *chaung* and its branches during the rains, and careful removal of all floating debris.

5. Strict prohibition at all times against the dumping of rubbish in any drain, or water course.

6. A more extensive use of quinine by the general population.

It should be regarded as the principal duty of the local medical staff—with such aid as the Educational Department may be able to afford in the way of lantern lectures and diagrams—to explain and popularise the use of quinine.

XI.—*Malarial preventive measures considered as regards the Province in general.*

The following conclusions, based on the writer's investigations, appear to be of general application :—

1. The presence of stagnant water collections containing decaying vegetation all the year around, is especially favourable to the prevalence of anopheles of malaria-carrying species.

2. Excessive prevalence of Barbirostris appears to be associated with the existence of a primary mode of malarial infection, which is not that habitually derived from a human focus : and it is likely that Blackwater Fever is a symptom complex which results from this mode of infection *at its worst*.

3. If *Myzorhynchus Barbirostris* is the main carrier from a primary source, the abolition of that species, which is comparatively easy, should have a more

* Coal tar one pint, turpentine one pint, soft soap one ounce, made up to two gallons by the addition of water, (cost, Annas 6) sufficient for the effective treatment of 300 gallons of water (*vide* page 7, Report upon the Prevalence of Stegomyia Fasciata at the principal seaports and seaport towns in Burma).

permanent effect in ameliorating malarial conditions, than the abolition of anopheles of ordinary malaria-carrying species—which probably act chiefly as carriers of secondary infection from man to man.

The writer's final conclusion is, that much in the way of amelioration of malarial endemicity may be expected from :—

1. The abolition of all stagnant water collections containing decaying vegetation, between the months of November and April every year; and the regular weekly treatment with larvicide during these months of stagnant water collections of this nature which cannot be removed.*

2. A more extended use of quinine by the people, in malaria-stricken localities, in the treatment of relatives—especially of children—suffering from malaria.

3. The cutting down and burning of all scrub jungle—in, and for a radius of one mile around, every malaria-stricken centre of population—twice yearly; during the hot weather, and as early as practicable after the close of the rains.

Conclusion.—In concluding this report the writer desires to express his obligation to Mr. W. B. Tydd, Deputy Commissioner, Katha District, for valuable assistance in the course of the investigation, to Maung Po Kyaw, Subdivisional Officer, Wuntho, for the promptness and thoroughness with which he seconded the writer's enquiries, and to Mr. E. L. George, Superintendent of Land Records, Katha District, who kindly placed a draughtsman at his disposal for the preparation of the maps which accompany this report.

N. P. O'GORMAN LALOR, M.B., D.P.H.,
Major, I.M.S.

RANGOON, 16*th June* 1913.

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(1) Anopheles Mosquitoes of India (2nd Edition)—James and Liston.

(2) Report of Investigation of Malaria at Kyaukpyu—Office of the Superintendent, Government Printing, July 1912.

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(4) Proceedings of the Third Meeting of the General Malarial Committee held at Madras, November 1912 (*loc. cit.*)—Simla, Government Central Branch Press, 1913.

(5) Treatise on Zoology, Part I, Introduction and Protozoa (Second Fasciele)—E. Ray Lankester, Ed.

(6) Wanderings in Burma—Bird (Burmese Educational Department).

* Drinking water tanks, and cattle watering tanks in the open, kept free from surrounding jungle and floating vegetation, and trimmed at the margins, are harmless in this connection. Malarial centres as a rule moreover, own perennial sources of water supply which render the construction of such tanks unnecessary.

G.B.C.P.O.—No. 31, I.-G. C. H., 13(*a*) 20-6-1913—178—F. X. deC.

REPORT

ON

CERTAIN FEATURES OF

MALARIA

IN THE ISLAND OF SALSETTE

BY

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PREFACE

Government Resolution, General Department, No. 4008 of 26th June 1912, runs as follows :—

"His Excellency the Governor in Council is pleased to direct that Major J. L. Marjoribanks, I. M. S., Deputy Sanitary Commissioner, Western Registration District, be deputed to investigate the malarial conditions prevailing in the Island of Salsette with a view to ascertaining and defining the dangerous malarious tracts of the táluka and indicating the direction in which and the limits within which residential development should proceed. Major Marjoribanks should also enquire and consider what measures are possible for the removal or abatement of the causes and conditions which give rise to Malaria in the tracts affected. He should carry out the enquiry during the months of September and October when the incidence of the disease will be at its height, and report the result to Government through the Sanitary Commissioner. During this time he will remain in charge of his ordinary duties."

In a subsequent resolution the period allowed for the investigation was extended by a month.

The examination of a representative number of blood-films to determine the endemic index, and the dissection of mosquitos caught in houses, to ascertain which species are the local carriers of Malaria, could only have been undertaken by a full-time Malaria Officer, especially over so large an area as that of Salsette. Accordingly, the present investigation was limited to an examination of the Vital Statistics of Salsette, to collection of larvæ and adult anopheline mosquitos throughout the island, and their identification at a temporary headquarters, and to the taking of a Spleen Census of the children in the villages and hamlets.

For the collection of larvæ and adult mosquitos four compilers of the Sanitary Department were employed on a scale of pay similar to that of the Malaria Sub-Inspectors of the Health Department of Bombay Municipality, and two of them received preliminary training under the Malaria Assistant to the Health Officer. Each was given a cooly, paid at the Bombay rate.

The identification of specimens and the Spleen Census were carried out in person by the writer.

He acknowledges heartily the assistance rendered to him and the information given, by the Revenue, Educational and Meteorological Departments, and also the help he received from the parish priests and other clergy of Salsette.

If this report is read from the point of view of town-planning in Salsette it is assumed that the report "On the possibilities of development of Salsette as a residential area", by Mr. P. J. Mead, I. C. S., is available for reference.

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References
Enam Village
Bazar Village
Khoti Village
Sharakati Village
Lakes
MAP
of the
SALSETTE TALUKA
of the
THANA COLLECTORATE
Compiled from Topographical Survey of India
Scale 2 Miles – 1 Inch
BASSEIN TÁLUKA
BHIWNDI TÁLUKA
KALYAN TÁL.
KOLABA COLL.
MAHIM BOMBAY
FORT
BASSEIN CREEK
DHÁRAVI FT
MAHAD FT
SIWRI FT
THANA
THANA CREEK
MAHIM CREEK
Ghodbandar
Bandra
Trombay
Govt. Photozinco Office, Poona, 1917

CHAPTER I.

GENERAL DESCRIPTION OF SALSETTE.

The island of Sáshthi, or Salsette, lies just north of the 19th parallel of North Latitude on the west coast of India, and close to the mainland. The táluka of Salsette in the Thána District, to which it belongs, and of which it forms all but a strip on the mainland of about 47 square miles, known as the Khairan Patti, is some 250 square miles in extent. Salsette island is separated on the North and East from the mainland by a creek, of which the northern arm is known as the Bassein Creek, and the eastern the Thána Creek. To the South lie Bombay Island and Bombay Harbour. The táluka has a population of some 150,000 people in 140 towns and villages.

PHYSICAL GEOGRAPHY AND GEOLOGY.—The most striking feature of the geography of Salsette island, and one which has a very important bearing on its malariology, is its range of hills, the highest peaks of which are over 1,500 feet, though within a few miles of the sea. This range forms, as it were, the backbone of the island, and runs, diminishing in height, from the northern end southward. In the southern portion of the island is an area devoid of hills, though in the south-east corner, in what is known as the Island of Trombay, at the head of Bombay harbour, there is a hill 1,000 feet in height, of the same nature as the hills that run down the centre of the island.

Spurs from this main line of hills run westwards towards the sea.

Among the hills lie two artificial lakes, Tulsi and Vehar, which provide part of Bombay's water-supply. A third, Powai Lake, has in more recent times been constructed for the same purpose south of Vehar, though the shallowness of the bed has prevented the water stored from being of a quality that could be used.

The west coast is deeply indented by creeks, the two principal of which are the Malád and Manori Creeks, which detach, or almost completely detach, considerable portions of the land at spring tides.

It is unfortunate that there has never been a geological survey of Salsette. A geological map would have been useful in the present connection, for, as will be seen, there is a relation between the geology of the island and its malariology.

The hills of Salsette are of the same volcanic origin as those of the rest of the Konkan and the Deccan at this latitude. The relative steepness of its hills on their eastern face is as noticeable as in the case of the hills of Bombay Island, and depends on the fact that there is a dip in the strata to the westward of from 10° to 15°, the strata near the coast being, as a matter of fact, of a higher series than those far up in the ghauts. Most of this volcanic rock in Salsette is trap, derived from the lava of ancient volcanos, but in places the rock is breccia, derived from their ash.

There is certain amount of sedimentary rock to be found, however, especially in the South of the island, where it is continuous with that lying in the bed of what was once a great fresh-water lake, part of which covered areas now in the Island of Bombay.

The soil derived from the disintegration of the trap, which, if it contained more organic matter and were of a darker colour, would be known as a cotton soil, extends from the bases of the hill scarps down towards the sea. By the sides of the creeks it gives place to alluvium which, brought down to the coast by streams, has been washed back by the sea to form the flats that line the creeks of the island and are mostly submerged at spring tides. The alluvium is thus heavily impregnated with salt.

Along the west coast of Salsette are a series of what at one time were sea rocks, but which, by the gradual silting up of the creeks by alluvium, are now only separated from the land by the flats. The villages of Bháyndar, Dongri, Uttan, Gorai, Manori, Marva, Malavni, Akse, Yerangal, Marh, Daravli, Vesáve, Juhu and Bándra are all built upon islets recently more or less assimilated to the land in this way. In some of those places the trap shows itself and forms considerable ridges. In some it occurs in different stages of disintegration as muram, red earth and even soil on which rice and rabi crops can be grown. In other places any soil that has formed has been obliterated by blown sand, which forms dunes that line the shores opposite some of the villages.

Coincidently with the process of silting up of the creeks there is in progress at some places a process of coast erosion going on which by the end of each monsoon noticeably alters the outline of the shore of certain localities, such as the islet of Juhu, to the North of Bándra.

CLIMATE AND RAINFALL.—There being no observatory on the island of Salsette no record of the temperature is available. The climate of the west coast is very much like that of Bombay, where January has an average mean temperature of 73·9° and May one of 84·7°. In the eastern or inland parts of Salsette the temperature varies considerably with the variations in geographical and geological formation.

In Bombay, as shown by the records of the Colába Observatory, winds are northerly in November, December, January and February. From the middle of March they begin to change to a westerly direction, and from the beginning of April to the end of September the prevailing direction of the wind is westerly; during the first half of October winds are unsteady and slowly change to a northerly direction. The south-west monsoon breaks in June, is at its height in July and August, and is over early in October. The north-east monsoon occasionally gives showers in November and December.

The following statement gives the total rainfall for the years 1902 to 1911 at Kurla and Thána. The greater precipitation at Thána is due to the influence of the hills of Salsette, which lie between the town and the sea. Even at Kurla the rainfall is slightly greater than at places actually on the coast:—

Year.	Rainfall at Kurla in inches.	Rainfall at Thána in inches.	Year.	Rainfall at Kurla in inches.	Rainfall at Thána in inches.
1902	77·62	81·17	1907	97·71	105·38
1903	103·62	126·97	1908	82·31	87·65
1904	60·89	91·98	1909	105·04	113·66
1905	43·78	58·32	1910	74·71	82·88
1906	72·22	84·48	1911	54·22	71·92

TREES AND CROPS.—Part of the central hill area is under "forest", the term being used in its technical sense. But almost everywhere, from the hill area right down to the alluvium, the soil of Salsette island supports a growth of trees and long grass, only interrupted by the rice-fields which cover so large an area of the island. Round the villages the commonest trees one finds are the Āmb (*Mangofera*), the Chinch (*Tamarindus*), the Sītāphal (*Anona*), the Bhendī (*Thespesia*), the Karanj (*Pongamia*), the Sāg (*Tectona*), the Rājan (*Mimusops*), the Bor (*Zizyphus*), the Kājū (*Anacardium*), and, among palms, the Tād (*Borassus*), the Nāral (*Cocos*) and the Shindī (*Phœnix*). So near a large city, both the long grass and the produce of many of the trees form a considerable commercial asset. Even the villas that line the Ghodbandar road, near each of the railway stations of the B. B. & C. I. Railway, from Andheri northwards, and which are at once the hope and the despair of the town-planner, are enveloped in palm or mango-orchards supporting a rank growth of grass.

PRICES.—Rice of the second sort is the staple food in Salsette Táluka. The following are the rates per rupee from 1901 to 1912 :—

Year.	Seers (80 tolás =1 seer).	Chattaks.	Year.	Seers (80 tolás =1 seer).	Chattaks.
1901	10	3	1907	9	4
1902	10	3	1908	7	6
1903	11	2	1909	9	4
1904	10	3	1910	9	2
1905	10	2½	1911	8	2
1906	9	14½	1912	7	5

POPULATION, CASTES AND EMPLOYMENT.—The three municipal towns of Salsette are Thána, Bándra and Kurla. Their census population, with that of the rest of the táluka, is given in the following table :—

Name of town or rural circle.	Census of 1891.	Census of 1901.	Census of 1911.
Thána	17,455	15,410	15,591
Bándra	18,317	22,075	22,885
Kurla	11,469	14,831	15,081
Rural Salsette	78,878	94,016	98,895
Total population of táluka ...	126,119	146,332	152,452

The chief occupation of the rural population is the cultivation of rice, on which not only members of regular agricultural castes but a great many other people are mainly dependent for their livelihood. Though there is only the one crop, and the rice-fields lie fallow for the rest of the year, the various processes incidental to the cultivation and storage of rice seem to provide the average cultivator or field labourer with work for the year round. A certain amount of market-gardening is done, especially in the coast villages, and in different places timber-felling and carting, grass-cutting, mango-growing, toddy-drawing, sea-fishing and salt and lime working provide the different castes with employment. Though there are a few large mills at Kurla town in the South of the island there is not the migration for work in the mills of Bombay that is so marked in the sea-coast tálukas of the neighbouring Kolába District.

In rural Salsette there is little of a Musalman population. Of the better class Hindus there are a certain number of Bráhmins and Parbhus. Besides those who more or less definitely follow some one occupation, such as Dhobis, Lohárs, Shimpis (tailors), Mális and Sonárs, and those whose occupation has always been mainly agricultural, such as Maráthas, Pánchkalshis and Dhodyas, there are castes who have more or less deserted their tribal or caste occupations to become occupiers of agricultural land or field-labourers, such as Agris (originally salt-workers), Bhandáris (originally only toddy-drawers) and Dublis and Varlis (originally forest tribes). The population of some villages mainly consists of Kolis, the term Koli being applied to several groups of fishermen and cultivators of mixed descent now classed as Hindus. Mahárs are met with, mostly in their capacity as out-castes and village servants, but also sometimes as well-to-do labourers, and even mechanics.

All along the coast, both in the town of Bándra, and in the villages, a proportion of the population, most unusual for the Bombay Presidency, consists of Indian Christians. These are the descendants of the early converts of the Portuguese. In the villages they are nearly always cultivators, but Bándra town supplies Bombay with a considerable number of its clerks and mechanics. They are rapidly learning English, and becoming more and more Europeanized in their dress. Although their higher standard of living makes them more resistant to Malaria than many of the classes among which they live,

their villages have at times been severely visited by Plague, which has considerably reduced the population in some of them. Moreover, they are fond of showing their independence of the Brâhmin official, and one manifestation of this tendency, consisting of frequent refusal of the services of the vaccinator, renders them peculiarly liable to Small-pox.

The Bándra-Dánda Peninsula, and especially the ridge known as Páli Hill, has for long had a considerable European population, consisting mostly of Bombay business men, who go in daily to their offices. Especially since Plague established itself in Bombay their example has been largely followed by well-to-do Indian business men, who have built villas round every railway station in Salsette where Malaria is not sufficiently bad to make residence quite impossible. Except in the case of some of the stations nearer Bombay, such as Ghátkopar, those villas are not inhabited in the rainy season, nor in the cold weather till it is drawing to a close, the fear of Plague, and the desire for fresh air being the main inducements to a semi-suburban or rural life in the hot season.

The matter of these groups of villas, and the desirability of controlling building by the introduction of the principle of town-planning, are fully dealt with in Mr. Mead's Report, and town-planning is now being regulated by a Special Officer appointed for the purpose by Government.

SALSETTE TALUKA

CHART. No. I.

SHOWING

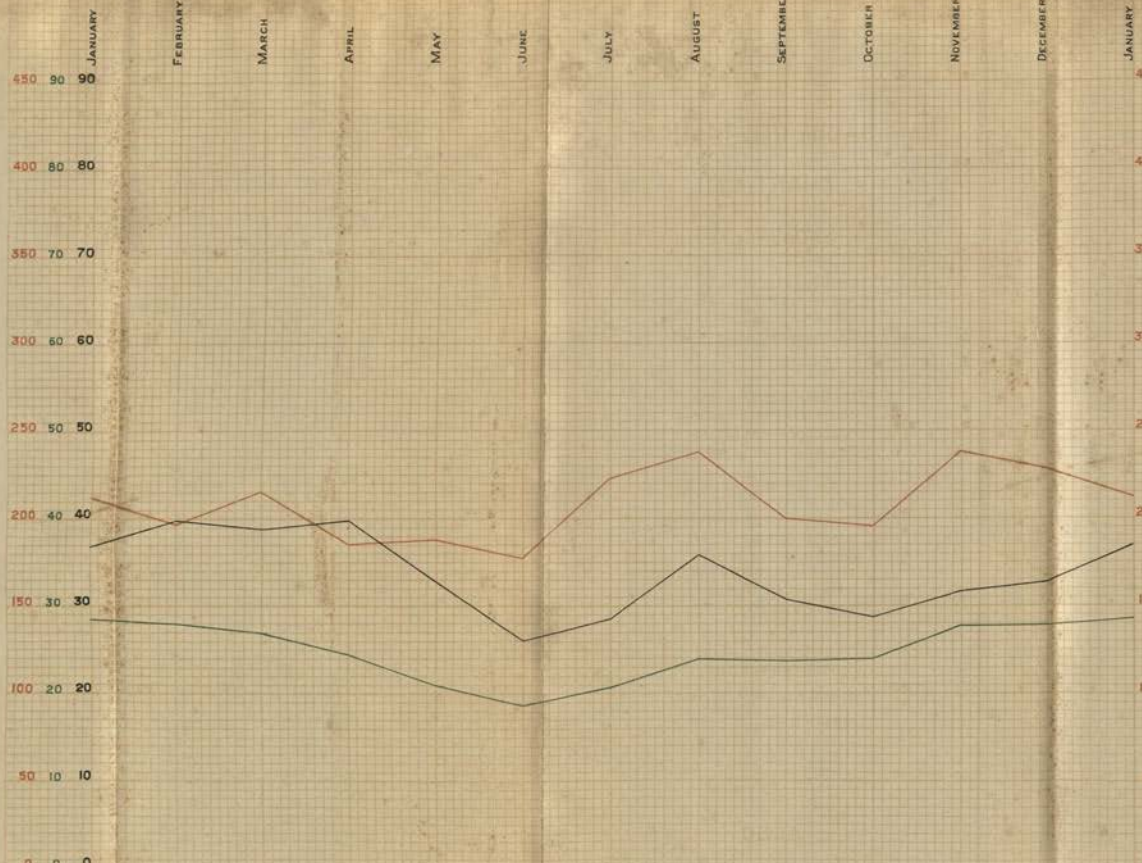
The mean annual death rate per mille of papulation for the ten years 1901-1910 for each month (black curve)

The same rate minus the death rates from Small-pox Plague, Cholera and Dysen-tery & Diarrhoea (green curve)

and

The mean annual death rate of children under one year per mille of Mean Annual births for the ten years 1901-1910 for each month (red curve)

(CORRECTED FOR THE NUMBER OF DAYS IN THE MONTH)



ALSO

N	N	NNW	NW	W	WSW	WSW	WSW	W	N	NNE	NNE	N
50	60	50	60	70	70	85	85	55	20	50	55	50
6·1	6·7	7·3	7·4	5·9	8·7	9·4	10·8	6·9	5·3	5·4	5·9	6·1

Normal mean wind direction at Bombay Observatory (Black letters)

Normal mean wind steadiness at Bombay Observatory (Black figures)

Mean wind velocity in miles per hour at Bombay Observatory (for one year only) (Red figures)

CHAPTER II.

VITAL STATISTICS.

Till near the end of the decennium 1901 to 1910 Salsette, for the purpose of the compilation of vital statistics, was divided into the Thána Town Circle and the Salsette Rural Circle. Since 1908 Bándra has been dealt with as a separate Town Circle, and it has recently been decided to constitute Kurla as a separate Town Circle from 1913. These separations of the urban from the rural population of Salsette will enable variations in the intensity of such diseases as Malaria, so much more a rural than an urban disease, to be more accurately studied over a period of years in the future than they can be at present.

In 1911 Captain B. Higham, I. M. S., when acting as Deputy Sanitary Commissioner, carried out for the Western Registration District the statistical enquiry ordered in Government Resolution, General Department, No. 4796 of 29th September 1910. He prepared charts for two series of years before and after the outbreak of Plague in the Presidency, showing curves for the mean monthly figures for each táluka, of Total Births, Total Deaths, and Infantile Mortality. He discontinued the plotting of curves for Still-births before he came to the vital statistics of the Thána District, as he found that the curves for different tálukas of the Násik District showed such a complete lack of conformity as to indicate that no reliance could be placed on the registration of Still-births. He also prepared tables showing "epidemic figures," on the lines laid down by Major Christophers. The compilations of Captain Higham, on which his curves were prepared, have been of considerable assistance in preparing the two charts that accompany this present report. Unfortunately, on account of the destruction of certain records, he was not able to obtain his pre-Plague figures for a decennium of continuous years. Apparently on account of some difficulty in ascertaining the populations on which some of the ratios should be calculated for this pre-Plague series of years, all the curves for the pre-Plague series, for Births, for Total Deaths, and for Infant Mortality, are below the corresponding ones for the post-Plague series. It was, accordingly, inadvisable to attempt to draw conclusions based on the differences shown between the several kinds of curves of the two series of years.

For the present report only the vital statistics of the intercensal decennium 1901 to 1910 have been taken. The figures are for the whole of Salsette Táluka, including its urban populations.

THE DEATH-RATE.—A description of the Seasonal Chart (Chart No. 1) is given on it. The principle followed in the preparation of the lowest curve in it has been that rural registration work, at any rate, is generally accurate as regards the *total* number of deaths, and that if the figures for certain diseases which (1) tend to be seasonal in their incidence, (2) are easily recognized even by ignorant persons and (3) are not themselves the sequelæ of Malaria, are deducted from the total, the residue will give a fair idea of the seasonal variations in mortality due to Malaria. A curve showing the death-rate among children under one year, calculated, not on the population, but upon the births, has been shown, both because this is the most accurate of all death-rates, and because it affords a very good indication of variations in the intensity of Malaria, infants being extremely susceptible to the disease. Letters and figures showing the normal mean wind direction and steadiness for the day for each month of the year at Colába (Bombay) Observatory are given at the foot of the chart, as also figures showing the mean monthly velocity of the wind in miles per hour for the year 1911. The "steadiness" is the excess percentage of observations in the direction of the monthly resultant.

It will be noticed that it is towards the end of the year that the Total death-rate curve and what we may term the curve of the Death-rate *minus* the rate for Special Diseases most closely approach each other, *i. e.*, it is then that there is least of those diseases. Early in the year they begin to diverge, as Plague begins to increase, and they remain widely apart for some months, their further divergence from each other in April being due to the superaddition of Cholera to Plague. The decline of Plague after April brings about a rapid fall in the

Total death-rate, which is not shared to any extent by the Infantile death-rate, and a greater approximation of it to the Death-rate *minus* the rate for Special Diseases. June is seen to be the all-round healthiest month. All the death-rates rise after the monsoon has well set in. The rise is better marked in the case of the Total death-rate than in that of the Death-rate *minus* that for Special Diseases, and more marked still, and earlier marked, in the case of the Infantile death-rate. Here Cholera, and Diarrhœa and Dysentery are in operation. Their decline in September and October with the dying away of the monsoon, and the approximation again of the two lower curves to one another, can be seen at a glance.

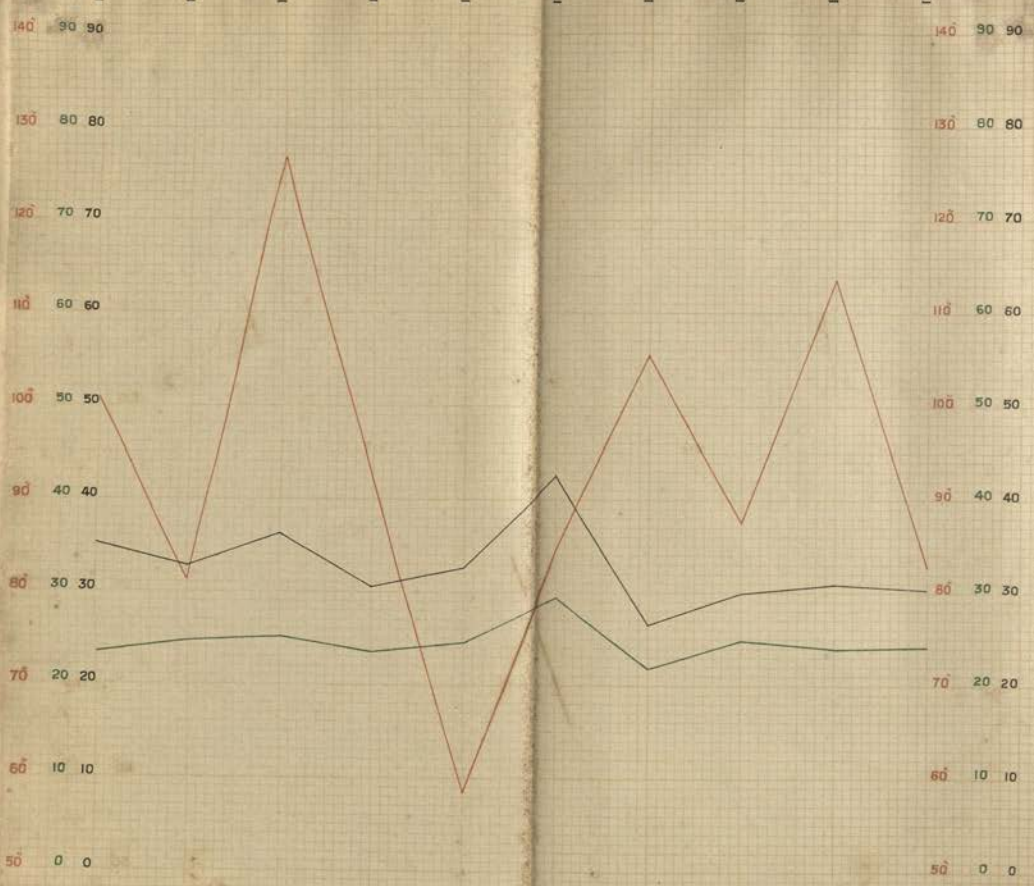
Malaria not being a disease that kills very rapidly, though it is accountable for so great a proportion of the deaths that do occur, it is not till the Malaria season is well established that its effect on the mortality is marked. In October there is slight rise in the Death-rate *minus* the rate for Special Diseases, but in the case of the other two death-rates any rise due to commencing mortality from Malaria is concealed by the fall in the mortality from diseases of the bowel. But in November the rise is very evident in all the death-rates; and, at a time when, as seen by the maximum approximation of the two lower curves on the chart to one another, there is less mortality from the Special Diseases taken together than at any other time of year, Infantile mortality is actually at its highest, because of the severity of Malaria at this season. In infants Malaria kills much more quickly than in adults, and less often through late complications, such as Pneumonia. This is probably the reason why the infantile death-rate is already falling in December and January from the maximum in November, while the Death-rate *minus* the rate for Special Diseases remains high, and actually reaches its maximum in January.

The continuous fall of this latter death-rate throughout the latter part of the dry season affords the best indication of the continuous decline that goes on then in the amount of Malaria. The curve for this death-rate certainly accords with the account the cultivators themselves give of Malaria, that is essentially a disease of the cold weather months, and that it is not till the warm weather commences that the country begins to be healthy. It is with the fall of this curve that the country residences of well-to-do Indians in Salsette begin to be occupied.

It will be noticed that it is in October that the wind is just changing round to the North, from the West, before beginning to blow steadily from the North in November, and that the reappearance of the Westerly element in March synchronizes with the commencement of this steady fall in the mortality that has been noted. This may be otherwise stated by saying that the absence of the sea-breezes coincides in point of time with the greater mortality from Malaria.

A description of the Yearly Chart for the intercensal decennium 1901 to 1911 (Chart No. 2) is given on it; it includes a curve for the variations in rainfall. The appearance of the curve showing the total Death-rate *minus* that for Special Diseases does not suggest that the death-rate from Malaria has shown any general tendency to increase during the decennium. Nor does it suggest that there was any very severe epidemic visitation of the disease. But it does show clearly two facts regarding the relation of Malaria to the rainfall that have been noticed in other parts of India. One is that a mere heavy rainfall does not of itself involve any necessary increase in the amount of Malaria. In the year 1909 the rainfall was over 113″, and in 1903 it was 127″, yet no marked rise in the amount of Malaria appears to have resulted in either case. The other well-known fact illustrated by this chart is that what does cause a marked rise in the incidence of Malaria is the occurrence of a year of defective rainfall followed by one of ordinary or even of rather less than ordinary rainfall. The most malarious year of the decennium was 1906, the rainfall for 1905 having been so extraordinarily low, for Thána, as to be little over 58″.

Hitherto variations in the incidence of Endemic Malaria have mainly been studied; it remains to be seen whether the figures do or do not give an indication of the occurrence of waves of Epidemic Malaria, such as have been



SALSETTE TALUKA

CHART No. 2.

SHOWING

The annual Death-rate per-mille for the years 1901-1910 (Black curve)

The same annual Death-rate less the Death-rates from Small-pox, Plague, Cholera and Dysentery & Diarrhoea (Green curve)

and

The total annual rain-fall registered at Thana town for the years 1901-1910 (Red curve)

shown, by a study of mortality figures, to have occurred in the Punjab. This is best shown by taking the mean of the deaths recorded throughout the decennium for some month which seems to have been free from special epidemic conditions, treating this figure as one, and subjecting the mortality figures for the different months of the different years to division by it, in order to see whether a high multiple of one is anywhere obtained.

In the following table the deaths for the different months of the different years of the decennium, less the deaths from the Special Diseases, are given, those figures which are less than ten per cent. above the mean of their particular month having been expunged, to show up the others more clearly :—

Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December	Years.
1901 ...	432	420	425	...	...	...	...	...	...	...	...	...	1901
1902 ...	...	...	...	...	...	...	...	...	344	364	389	449	1902
1903 ...	445	391	...	359	...	250	...	...	...	...	...	...	1903
1904 ...	...	...	...	...	...	249	...	...	...	...	...	...	1904
1905 ...	...	360	...	332	295	258	...	...	...	...	...	...	1905
1906 ...	...	...	439	361	337	283	333	386	...	350	407	384	1906
1907 ...	...	..	...	...	...	...	...	...	...	...	...	...	1907
1908 ...	...	...	...	...	...	...	...	351	...	...	...	...	1908
1909 ...	...	...	...	...	...	...	...	...	...	...	...	...	1909
1910 ..	...	...	...	...	...	...	...	...	...	351	409	384	1910

June being the month in which the Death-rate *minus* the rate for Special Diseases is lowest, its mean for the decennium may be taken as one. In the next table the figures for the first table have been corrected so as to be figures for months of thirty days. They have then been divided by the mean of the figures for June, and the result is as shown. The figures for the rainfall at Thána for the years of the decennium have been inserted at the left hand side of the table, the rainfall for 1899 and 1900 also being given :—

Rainfall at Thána in inches.	Years.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December	Years.
41·87	1899													
86·61	1900													
100·74	1901	1·8	2	1·8	...	...	...	...	...	...	...	...	...	1901
81·17	1902	...	...	...	...	...	...	...	...	1·5	1·6	1·7	1·9	1902
126·97	1903	1·9	1·9	...	1·6	...	1·1	...	...	...	...	...	...	1903
91·93	1904	...	...	...	...	...	1·1	...	...	...	...	...	...	1904
58·32	1905	...	1·7	...	1·5	1·3	...	...	...	...	...	...	...	1905
84·48	1906	...	...	1·9	1·6	1·4	1·3	1·4	1·7	...	1·5	1·8	1·6	1906
105·38	1907	...	...	...	...	...	...	...	...	...	...	...	...	1907
87·65	1908	...	...	...	...	...	...	...	1·5	...	...	...	...	1908
113·06	1909	...	...	...	...	...	...	...	...	...	...	...	...	1909
82·88	1910	...	...	...	...	...	...	...	...	...	1·5	1·8	1·6	1910

Nothing that could be called an actual Epidemic Figure is to be seen, and it may be concluded that, although variations in the intensity of Malaria did occur, Malaria did not visit Salsette in Epidemic form during the decennium.

It will be observed that the highest mortality occurs early in 1901, the effect of the failure of the rains in 1899 having been to make the Malaria season of 1900-01 an unusually severe one.

THE BIRTH-RATE.—The seasonal birth-rate curves for all the nine tálukas of the Thána District show the same variations for different months. Although rural Salsette so much resembles the average táluka of the Thána District its curve shows those seasonal variations to a much less degree than the others, probably on account of its being almost the only táluka with anything of an urban population. Accordingly the birth-rate curve of Salsette Táluka is not shown in either of the two charts. The seasonal birth-rate of rural Salsette is probably really better represented by the curves for the other tálukas. In Captain Higham's charts for the decennium 1901—1910 those all show a continuous rise from between 24 and 34 per thousand per annum in February to between 44 and 58 in May. This high birth-rate is maintained in June, but there is a rapid and a uniform decline to between 32 and 39 in July. There is some further almost uniform decline in September, nearly all the tálukas having then a birth-rate of 28 to 32 per thousand per annum. With a slight but nearly uniform rise in November, and an exactly corresponding fall in December, the rates remain about the same level till the beginning of the rise after February. The Peint Táluka of the Násik District, which is geographically a part of Thána District, shows this same peculiar curve, which is not that of the other tálukas of the Deccan district of Násik, and which is not accounted for by any seasonal migration of the population, for none takes place in Thána District.

This relatively great height of a birth-rate, the mean of which, 34·21 per 1,000 for the decennium, is not high for an Indian district, in the months of March to June, would appear to connote a relatively increased virility in the months of June to September. As the phenomenon is not observed in the Deccan it must depend on something which influences the Konkani to a much greater extent than the Deccani.

There is one thing that the inhabitant of the Deccan knows little of, and that is the extraordinary difference which the presence or absence of the sea-breeze makes to the vitality of the inhabitant of the Konkan. If a reference is made to the meteorological figures at the foot of chart No. 1 it will be seen how closely this period of relative virility coincides with the monsoon, how it suddenly begins with the access of velocity in the sea-breeze in June, and the appearance of the southerly element, and how it ends as abruptly in October when the wind shifts round from the West to the North and the Malaria season sets in.

CHAPTER III.

THE ANOPHELINE MOSQUITOS OF SALSETTE.

The following are the species of Anopheline mosquitos which were found in Salsette during the present enquiry:—

Myzomyia culicifacies.
Myzomyia listoni.
Neocellia stephensi.
Nyssorhynchus fuliginosus.
Nyssorhynchus jamesii.
Pyretophorus jeyporiensis.
Nyssomyzomyia rossii.
Nyssomyzomyia punctulata.
Myzorhynchus barbirostris.

It will be noticed that those are the same anophelines as those found on Bombay Island by Dr. Bentley, with the addition of *Py. jeyporiensis* and *N. punctulata.*

In Appendix I is given a table in which the anophelines are mentioned one by one, with the exact places where they have been found in the larval or adult state within the boundaries of the different villages, the latter being grouped according to the nearest railway stations.

In Appendix II another table gives the villages in alphabetical order, with the names of the different species, and the places in which they have been found. From both of those tables the record of *N. rossii* has been omitted.

It is hoped that this will facilitate any research that may in future be carried out in order to discover which mosquitos are the actual carriers.

In Appendix III notes are given on the apparatus used in collecting larvæ, and on the instructions issued to subordinates employed to collect them.

The first four of the anophelines mentioned have been found, in one part of India or another, to be carriers of Malaria.

The following table gives the proportion of adults captured and brought for identification from the East and from the West side of the island respectively, out of a total of 823 from the East side and of 1,168 from the West side. It will be noticed how closely the two sets of percentages resemble one another :—

Names of species.	East side.		West side.	
	Number caught.	Percentage of total.	Number caught.	Percentage of total.
Py. jeyporiensis	...	...	1	·08
N. punctulata	4	·48	...	...
Ny. fuliginosus	57	6·93	97	8·30
My. culicifacies	4	·48	2	·17
Ny. jamesii	2	·24	1	·08
My. listoni	4	·48	2	·17
M. barbirostris	23	2·80	26	2·22
Ne. stephensi	6	·73	2	·17
N. rossii	723	87·85	1,037	88·78
Total ...	823	...	1,168	...

The next table gives the proportion of the samples of larvæ of different species brought from different parts of the island, out of a total of 522 samples identified. As many as possible of the bottles of larvæ were kept standing in order to let the adults hatch out, scores of bottles being accordingly stocked for issue :—

Names of species.	Samples.	Percentage of total.
Ny. fuliginosus	145	27·78
N. rossii	115	22·03
My. culicifacies	93	17·82
Ny. jamesii	19	3·63
My. listoni	36	6·90
M. barbirostris	111	21·26
Ne. stephensi	3	·57

The figures for the larvæ are a much less reliable guide than those for the adults to the actual extent to which different species infest the island. The proportion of specimens of *N. rossii* larvæ found, for example, varies with the weather very greatly. A few weeks of dry weather is sufficient to cause their almost complete disappearance, and a single shower of rain to cause their re-appearance, at some places in every puddle or hoof-print.

It was unfortunate for the enquiry that the monsoon stopped unusally early, at the very beginning of September, as this made it impossible to conduct a really representative examination of the larvæ of the rice-fields.

WELLS.—The larvæ of six species, three of which, *My. culicifacies*, *My. listoni* and *Ny. fuliginosus*, are known carriers of Malaria in one part of India or another, were found in wells. The number of wells actually examined was not recorded, but, roughly speaking, two wells out of every three were found to contain the larvæ of one or more anophelines. Leaving out of consideration the wells in which the larvæ of *N. rossii* were found, and counting a well as one, two or three according to the number of species found in it, the following figures were obtained :—

Names of species.	Number of wells in which found.	Percentage of total.
M. barbirostris	54	33·75
Ny. fuliginosus	27	16·87
My. culicifacies	55	34·37
My. listoni	19	11·87
Ny. jamesii	5	3·12

BORROWPITS.—The borrowpits of the B. B. & C. I. Railway also deserve special mention, as they continue to breed mosquitos very late in the season, and long after most other temporary breeding-places have dried. Moreover, there is a chain of them running through the most malarious part of the country through which the line runs. A special re-examination of them was undertaken late in October, there having been practically no rain since the beginning of September. Larvæ were brought on this occasion from 55 borrowpits. Excluding 9 of them, in which only the larvæ of *N. rossii* were found, the proportion in which those of different anophelines were found was as follows :—

Names of species.	Number of borrowpits in which found.	Percentage of total.
Ny. fuliginosus	40	86·95
M. barbirostris	4	8·69
My. culicifacies	2	4·35

Notes on different Anophelines.

My. culicifacies.—The larvæ of this species were found in a great proportion of cases in wells. They were also found in streams, and would have been oftener were there more permanent streams in Salsette. They were also found in railway borrowpits and rice-fields. A very few adults were found in huts.

The larva is stated in James and Liston's "*Anopheline Mosquitos of India*" to have fully developed palmate hairs on the thorax. The present writer's experience, in several districts of this Presidency in which he has hatched out mosquito larvæ at different places, has been that palmate hairs are rarely found on the thorax in this species, and certainly never fully-developed ones. This is unfortunate, for it means that the larvæ of one of the principal Malaria-carriers of the west of India have to be put in the class whose characteristics are mainly negative.

My. listoni.—The larvæ of this species were also mostly found in wells. A few adults were found in cowsheds and other buildings.

In the standard description of this mosquito, given in *James and Liston*, the 3rd longitudinal vein of the wing is said to be white-scaled, this being one of the principal distinguishing characteristics, as this vein in the case of *My. culicifacies* is black-scaled. Dr. Bentley, however, states in his report that in the variety of *My. listoni* present in Bombay this vein is black-scaled. In Salsette, both in the case of adults caught in houses, and in the case of those hatched out from larvæ, the 3rd longitudinal vein of *My. listoni* was found to be white-scaled. This and the fact that the first dark area on the costa of the wing is not, as in the case of *My. culicifacies*, divided into two by a white spot, made it quite possible to distinguish *My. listoni* from the other, without having recourse to comparison of the relative length of wing-cells, as has been recommended.

Dr. Bentley further states that the larvæ of *My. culicifacies* are indistinguishable from those of *My. listoni*. There are species the larvæ of which may be difficult to distinguish from those of *My. culicifacies*, but as far as Salsette specimens go, the larvæ of no two species are easier to tell from one another than those of *My. culicifacies* and *My. listoni*, the appearance of those of the latter, with the large palmate hairs on the thorax and the abdominal palmate hairs conspicuously prominent at the sides of the segments, exactly corresponding with the illustration given in *James and Liston*.

Like *My. culicifacies*, *My. listoni* was not found to be the carrier by Dr. Bentley, in the case of the limited number of specimens of adults caught in Bombay Island and dissected, during his investigation. In parts of Bengal it is the chief carrier of Malaria, but it has not, so far, been found infected in Western India.

Neocellia stephensi.—This species, which is the carrier in the case of Bombay, is noted by Dr. Bentley as being scarce in the northern and non-malarious part of Bombay Island. In the Thána District, outside Salsette, the writer has found its larvæ in a nullah near Kalyán, and in the stream running into the creek at Bhiwandi just above the tidal limit. The present investigation has shown it to be so very scanty in Salsette that it is extremely unlikely to be the carrier of the Malaria which is so common over a large area of that island.

Ny. fuliginosus.—This is the tank-breeding mosquito *par excellence*. It is found in practically any tank one cares to examine in the Thána District. It is also the mosquito most commonly found in rice-fields and railway borrow-pits. Next to *N. rossii* it is the commonest mosquito in houses in Salsette. It is mentioned by Dr. Bentley as having been once found in Bombay.

In Burma and in Northern India this species has been found in some places to be the principal carrier of Malaria. Its ubiquitousness in Salsette

makes it difficult to hazard a guess as to whether it is likely to be a carrier there or not: that it breeds in numbers in non-malarious villages does not necessarily mean that it is not a carrier in malarious ones.

Ny. jamesii.—This is the species which seems to replace *Ny. fuliginosus* in Bombay Island, where it is very much commoner as a tank mosquito than in Salsette. It is distinguishable from *Ny. fuliginosus* in having speckled legs, and also by having certain differences in the scale markings of the veins of the wings. Even at a glance it is possible to tell the one from the other by the fact that *Ny. fuliginosus* gives the impression of having a dark wing with white spots, *Ny. jamesii* of having a light wing with black spots.

This mosquito is capable of being experimentally infected in the laboratory, though it has not been found infected in nature. It does not occur sufficiently commonly in Salsette to make it likely to be much of a carrier in any case.

Pyretophorus jeyporiensis.—This is not a widely-distributed species. Only one specimen, an adult, was found in Salsette. Its markings were as described in *James and Liston.*

Nyssomyzomyia rossi.—This is infinitely the commonest of the anopheline mosquitos. Though its breeding places are such as rapidly dry up at the end of the monsoon it was, as usual, present in houses and cowsheds in such numbers as very seriously to interfere with the collection of more important species. Neither in Bombay, where Dr. Bentley dissected large numbers of specimens, nor in other places has this, the first described of the Anophelines, been found to be infected. Were it a carrier hardly any one would escape Malaria.

Nyssomyzomyia punctulata.—This species is easily told from all other Anophelines by its having half the proboscis black, and the other half white. Adults were found in a few places in the eastern side of the island. No description of its larvæ has as yet been published, and it was not found to hatch out from any of the samples of larvæ brought for identification in Salsette.

Myzomyia barbirostris.—This mosquito is the third commonest in the houses and cowsheds of Salsette, and its larvæ are by far the commonest in the wells. It has a great preference for dark, shady places. It has been infected experimentally, but has not, so far, been found as a carrier in Nature.

GENERAL CONCLUSIONS.—In the absence of dissection of captured adult mosquitos, to discover which are the carriers, it cannot be said that any definite indication can be found from a study of the distribution of Anophelines in Salsette. Mosquitos there are, which have a definite reputation elsewhere as carriers of rural Malaria, but they are to be found in places that, as tested by the Spleen Census, are quite free from Malaria, as well as in places notoriously subject to it, and the carrier of the urban Malaria of Bombay is very scare in Salsette.

Whatever be the carrier it is evident that something more than the presence of facilities for breeding in abundance is required. The presence of sufficient dampness and shelter from the wind to enable the female to survive in considerable numbers till she becomes infected, and, further, until the parasite has gone through that part of its cycle which takes place in her body, and is present in her salivary glands, appear to be the factors which must be present to determine the malariousness of a locality.

MAP OF SALSETTE.

Scale 1-1 Mile.

Showing the SPLEEN RATE or percentage of indigenous children that have enlargement of the spleen, in the towns, villages and hamlets of Salsette Island and a few of the villages of the adjoining mainland.

Figures from 0 to 10 per cent are given in green.
Figures over 10 and not over 25 per cent are given in orange.
Figures over 25 and not over 50 per cent are given in brown.
Figures over 50 per cent are given in red.
Fractions of one per cent are only given in the case of percentages below ten.
Figures representing percentages calculated on fewer than 20 children are surrounded by a ring.
Villages almost or quite deserted on account of Malaria are underlined in Red.

In the righthand margin is a list of places, with a letter and a figure opposite each, to assist in finding it on the map. The letter corresponds with one of the letters along the top and bottom of the map, and the figure with one of the figures at either side.

If one forefinger is run inwards vertically from the letter, and the other forefinger horizontally from the figure they will meet at or near the place sought for.

CHAPTER IV.

THE SPLEEN CENSUS.

The percentage of indigenous children showing enlargement of the spleen, a condition rarely due in childhood to any other cause, has been found to a most excellent means of judging of the extent to which Malaria prevails in a community.

In working out the Malariology of an area sufficiently limited to be dealt with completely, the taking of the Spleen Rate, as it is called, is only one of a number of means of study. But the Spleen Census by itself gives results so accurate and so rapidly obtainable that when it is merely a case of finding out whether a given tract of country is malarious or not, or of judging of the relative malariousness of different parts of one, it is neither practicable nor necessary to combine with it any other means of demonstrating the amount of Malaria present. A Spleen Census among children has accordingly been used as the best method of demonstrating the great variations which exist in the extent to which the different parts of Salsette are affected by the disease.

The accompanying map of the island of Salsette shows the percentage figure of the Spleen Rate marked in under the name of each town or village. In order to show more graphically the wide differences that exist between different places in respect of Malaria, different colours have been used. Figures up to 10 per cent. have been entered in green; those up to 25 in orange; those up to 50 in brown, and those above 50 in red.

It is an obvious possible use of this map to take its figures as a guide in making out another map, showing the whole island marked out in patches of colour, according to their relative malariousness or non-malariousness, in order to assist those who have to judge of where to build and where not to build. But the *boundaries* of such coloured areas would be very difficult to determine in any reliable manner, and the more so in those very parts where Malaria has so thinned the population that the means of taking a representative Spleen Census are absent. It is better not to attempt to make the figures show more than they do show, and to trust to the general lessons they teach for guidance, in areas where they do not give detailed information.

While the Spleen Rate is not influenced by the severity or otherwise of a particular Malaria Season to anything like the same extent as an Endemic Index consisting of the percentage of children found to harbour the malarial parasite in the blood, it is only to be expected that good and bad years should make some difference in it. It is well at the outset to note, then, that the year 1911, which is the one whose Malaria season would exercise the greatest influence on the Spleen Rate taken in 1912, was a distinctly mild fever year, as the season of 1912 promises to be also, so that the figures certainly do not over-estimate the extent to which Malaria prevails in Salsette.

The following table gives in alphabetical order the towns, villages and hamlets in which the Spleen Census was taken. In the case of the villages round Thána, it was taken by the writer in December 1911, in the course of an investigation carried out in order to find out if any part of the environs of Thána was sufficiently non-malarious to allow of the building of residences for district officers. Here the Spleens are not classified according to size. In the case of the villages and towns of the rest of the island, in which the Spleen Census was taken in October and November 1912, as part of the special investigation which is the subject of this report, they are classified according to the method recommended by the Central Malarial Committee. In all 7,156 children were examined :—

Village or Hamlet.	Place on map.	Size of spleen in children examined.					Total of children examined.	Spleen rate per cent.
		Spleen not enlarged.	Spleen just palpable.	Spleen 2—3 fingers breadth below ribs.	Spleen a hand's breadth below ribs.	Spleen extending down to navel.		
Aksa	12/C	17	...	...	...	...	17	*Nil.*
Ambivli	15/E	84	1	...	2	1	88	4·5
Andheri	16/E	71	1	1	...	...	73	2·7
Anik	23/H	28	4	5	1	2	38	26
Babhai, Hamlet of Eksar ...	8/F	73	7	7	...	...	87	16
Balkumb	9/N	Spleens not classified.			...	...	65	22
Bamanwada	17/F	20	...	...	...	...	20	*Nil.*
Bandra-Danda Peninsula	19/G	1,000	...	1	...	...	1,001	0·09
Bhandup	14/L	78	15	15	3	1	112	30
Bharodi, Hamlet of Pahadi ...	13/E	14	1	3	2	...	20	30
Bhatti, Hamlet of Bhandup ...	13/K	3	4	16	5	3	31	90
Bhayandar	3/E	110	1	...	...	1	112	1·78
Bombay Refuse Depôt	20/I	41	...	...	...	...	41	*Nil.*
Borla	21/I	35	1	3	...	...	39	10
Borivli	8/E	54	...	6	...	...	60	10
Charkop	10/C	75	...	...	...	...	75	*Nil.*
Charai, Hamlet of Chembur... ...	21/H	67	...	5	...	...	72	7
Chembur	20/I	141	3	3	1	...	148	4·2
Dahisar	6/F	57	5	9	2	...	73	22
Dahisar Hamlets	7/G	4	11	29	8	...	46	91·3
Danda—see Bandra-Danda Peninsula ...	19/D	...	...	...	...	...	...	...
Daravli	13/C	12	...	1	...	...	13	7·7
Devi, Hamlet of Magatna	9/G	8	3	2	2	...	15	46·6
Devnar	21/J	51	...	...	2	...	53	3·7
Dhokale, Hamlet of Balkumb... ...	8/N	Spleens not classified.			...	...	35	93
Dongri	4/C	74	...	...	...	...	74	*Nil.*
Gavhan, Hamlet of Mulund	12/M	Spleens not classified.			...	...	50	40
Gavhan, Hamlet of Mahul	23/I	6	5	6	2	2	21	71
Ghatkopar, Forest Tribes	18/I	6	2	7	4	3	22	72·7
Ghatkopar, Commercial Castes ...	19/I	109	6	...	...	...	115	5·2
Ghodbandar	4/H	69	3	14	1	1	88	22
Gorai	8/A	163	1	...	1	...	165	1·2
Gundavli	16/F	12	1	1	...	1	15	20
Hariali	15/J	4	2	8	3	...	17	76·5
Ingal Khind, Hamlet of Marol ...	15/H	2	3	5	2	...	12	83·3
Iravli	13/O	Spleens not classified.			...	...	37	64
Itawa	11/O	Spleens not classified.			...	...	66	24
Juhu	17/D	116	...	...	...	...	116	*Nil.*
Kakda, Hamlet of Magatna	8/G	6	6	9	4	...	25	76
Kalva	10/O	Spleens not classified.			...	...	27	15
Kalva, Hamlet of Gorai	8/A	40	...	...	...	...	40	*Nil.*

Village or Hamlet.	Place on map.	Size of spleen in children examined.					Total of children examined.	Spleen rate per cent.
		Spleen not enlarged.	Spleen just palpable.	Spleen 2—3 fingers breadth below ribs.	Spleen a hand's breadth below ribs.	Spleen extending down to navel.		
Kandivli	10/E	92	4	3	...	...	99	7
Kanheri	8/F	18	...	3	2	1	24	25
Kanjur	15/K	6	5	12	9	3	35	83
Kashi	5/H	43	12	18	2	...	75	43
Khari	3/F	Spleens not classified.			...	...	90	30
Kharodi Hamlet of Malavani ...	10/D	41	...	...	...	...	41	*Nil.*
Kirol	19/I	56	16	7	1	1	81	30
Kolori	8/E	20	...	...	...	...	20	*Nil.*
Kolhe Kalyan	19/F	179	...	...	2	...	181	1·1
Kolshet	7/O	Spleens not classified.			...	...	44	84
Kondivate	16/G	5	...	2	...	...	7	71·4
Kurla (new)	20/H	128	1	1	...	...	130	1·5
Kurla (old)	19/H	103	...	3	...	...	106	2·8
Mahn Budruk	22/K	8	2	10	1	2	23	65
Mahn Khurd	21/K	51	2	4	...	...	57	11
Mahul	23/H	67	2	6	...	...	75	11
Malad	11/E	209	2	18	...	...	229	9·5
Malavan	10/C	88	...	...	...	...	88	*Nil.*
Mandala	21/K	23	3	3	...	...	29	20
Manjivda	9/N	Spleens not classified.			...	...	37	43
Manori	10/B	209	...	...	...	...	209	*Nil.*
Manpada Hamlets ...	8/N	Spleens not classified.			...	...	40	90
Maravli	21/H	33	1	2	1	...	37	11
Marh	14/B	45	...	...	...	...	45	*Nil.*
Marol	16/B	106	3	8	1	1	119	10
Marve	11/C	36	...	...	...	...	36	*Nil.*
Masha Hamlet of Kashi ...	5/H	6	3	12	2	1	24	75
Mira	5/G	52	10	15	3	3	83	37
Mhatarya tsa pada, Hamlet of Ambivli ...	15/E	9	1	2	...	...	12	25
Mulund	12/L	Spleens not classified.			...	...	11	64
Nana, Hamlet of Mulund ...	13/L	Spleens not classified.			...	...	28	71
Navghar, Hamlet of Mulund ...	13/M	Spleens not classified.			...	...	49	83
Navpada	11/M	Spleens not classified.			...	...	26	77
Naytodi, Hamlet of Eksar	8/E	19	1	...	...	...	20	5
Pahadi	13/E	11	4	5	...	2	22	50
Pali, Hamlet of Dongri	4/B	34	2	...	...	...	36	5·6
Poisar	9/E	69	10	7	3	1	90	23
Raimurda	4/D	158	...	1	...	...	159	0·6
Santa Cruz	19/E	64	...	...	...	...	64	*Nil.*
Shahad	17/G	49	2	7	...	...	58	16
Shimpoli	9/E	20	...	1	...	...	21	4·76

Village or Hamlet.	Place on map.	Size of spleen in children examined.					Total of children examined.	Spleen rate per cent.
		Spleen not enlarged.	Spleen just palpable.	Spleen 2—3 fingers breadth below ribs.	Spleen a hand's breadth below ribs.	Spleen extending down to navel.		
Sutarwada, Hamlet of Shahad ...	18/G	17	1	...	...	...	18	5·5
Tale, Hamlet of Eksar	8/E	58	...	...	...	...	58	*Nil.*
Tari, Hamlet of Kolset	7/O	Spleens	not clas	sified.	...	...	27	41
Tarodi, Hamlet of Dongri	4/C	29	1	1	...	...	31	6·5
Thakur, Hamlet of Eksar	8/E	21	2	1	...	...	24	12·5
Trombay	22/L	74	1	...	...	...	75	1·3
Utan	5/E	194	1	1	...	...	196	1
Vakola, Hamlet of Kolhe Kalyan ...	19/F	53	...	...	...	...	53	*Nil.*
Valnai	11/E	37	4	...	...	...	41	9·8
Vesava	14/C	108	2	...	...	...	110	1·8
Vikhroli	17/K	2	3	12	8	13	38	95
Vila Parla	18/E	127	1	...	...	...	128	0·78
Vadavli (in Trombay)	21/I	13	7	5	2	1	28	54
Vadavli (N. of Thána)	5/M	Spleens	not clas	sified.	...	...	133	59
Wagbil, Hamlet of Kavesar	6/N	Spleens	not clas	sified.	...	...	164	42
Yerangal	13/B	60	...	...	...	...	60	*Nil.*
Yeur	8/L	Spleens	not clas	sified.	...	...	88	94
Total of Children examined ...	...	...	...	...	...	...	7,156	...

The Spleen Census has its Scylla and Charybdis. On the one hand, if one strikes a percentage on a very small number of children, as one sometimes must, if hamlets are to be taken separately from the villages to which they belong, there is a certainty of a very obvious kind of error. On the other hand, if the figures for a village and a small hamlet belonging to it are added together for the purpose of striking the percentage on as large a figure as possible, though the children of the hamlet have a larger proportion of enlarged spleens than those of the village, the percentage struck is not accurate either, being rather higher than that of the village, and a good deal lower than that of the hamlet.

The principle here followed has been to compound the figures for a village and its hamlets only when there was no great difference found between the proportions of enlarged spleens, and to employ a special sign on the map to indicate a place where the rate has been calculated on a very small number of children.

In this connection the matter of class composition in different villages and hamlets must be alluded to. It is found, as a rule, that the poorer fed a class or caste of people is, the more liable are its members to Malaria, and *vice versâ*, and the peoples of Salsette are no exception to the rule. The children of the well-to-do commercial castes who reside in villas in Salsette for part of the year may be left out of account; their Spleen Rate would not have been taken even had they been in residence, as their children are not born and bred in Salsette. Bráhmins, again, form such a relatively small proportion of the inhabitants of villages that no conclusions can be based on any figures relating to their children. But in some villages almost the whole, and in others quite the whole of the inhabitants are Indian Roman Catholics, and it was quite noticeable that their higher standard of living makes them tend to have a lower Spleen Rate than the average of cultivators. At the other end of the scale the distinctly

primitive castes, such as the Dublas and Varlis, tend to have the highest Spleen Rate of all.

Had it been possible to have dealt with this factor of the standard of living alone, and to demonstrate its influence by comparing the Spleen Rate, say of considerable numbers of Christians with that of considerable numbers of Dublas living under identical conditions, instructive figures could have been obtained. But in Salsette it is another factor that mainly determines the amount of Malaria in a given number of people of any class, namely, the physiographical situation of their villages. Indian Christians in Salsette tend to live in villages in non-malarious areas by the sea: Dublas and Varlis tend to live in hamlets in malarious areas on the lower slopes of the hills. That when, as an exception, Indian Christian cultivators live in a particularly malarious area, they suffer as badly as anyone could, is shown by the case of the entirely Christian village of Vikhroli, where the Spleen Rate was 95 per cent, and where the proportion of very large spleens was particularly high.

On account of this impossibility of comparing different peoples living under sufficiently identical conditions no attempt at classification by race, religion or caste has been made, and this fact must simply be allowed for in considering the value of the Spleen Rate as it was taken.

As in other places in India, the tendency of urban areas to be remarkably free from Malaria is strongly manifested in Salsette. This tendency is apt to be slightly exaggerated in a Spleen Census of mixed urban and rural areas, from the fact that, without very special measures, such as house-to-house visitation, one is almost wholly dependent for the Spleen Census in towns on the examination of school-children, as the street children, among whom the percentage of enlarged spleens might be expected to be higher, cannot be collected in the ready way in which they usually are in villages. But, allowing for this, the tendency is remarkably evident. Exceptionally great facilities for the propagation of the local carrier of Malaria, such as there are in the malarious wards of Bombay City, appear to be necessary, otherwise a densely-populated urban area is the last place where Malaria is to be found.

The table shows that out of 1,001 children of the Bándra-Dánda Peninsula, of whom by far the most were born and bred in Bándra bazaar, only one was found on examination to have enlargement of the spleen. Making all allowance for the accessibility of Bándra to the sea-breezes the figures are very remarkable.

Still more significant, however, is the case of the Thána bazaar. The Spleen Rate here, which was taken by the Civil Surgeon, Major Kukday, I. M. S., was only 3·7 per cent. in the midst of a tract of country the intense malariousness of which may be seen by a single glance at the Spleen Map. Only the thick of the bazaar of Thána is non-malarious: the suburbs, such as Navpáda, are severely malarious.

The one phenomenon that is brought out most prominently by the map and its figures is the evident relation of Malaria to the range of hills shown on it. In other parts of India also the tendency has been observed for malariousness to increase as the hills are approached. Thus, in one investigation the percentage of children found to be infected with Malaria in the environs of Calcutta was nil; further and further north it was 12, 25, 40, 55, and at the foot of the Himalayas 72. And not only in Salsette but anywhere in the Thána District one finds it to be a fact well-known to the villagers, and capable of ready demonstration by the taking of a Spleen Census, that it is the dwellers on the slopes of the hills, or near their bases, that suffer most severely from Malaria.

In this connection the mainland part of the map, on the east side, may profitably first be studied. The remarkable feature of this part of the country, where the Parsik range of hills towers above the creek, is the line of villages along its sides that have been completely, or almost completely deserted on account of Malaria. (Villages thus deserted are underlined in red on the map.) In places down by the creek-side, such as Itáva and Iravli, the descendants of the former inhabitants of those villages are still living. All the

account they can give of the matter is that about forty years ago the villages on the slopes had to be abandoned on account of the "wāit hawa," (literally the 'mal-aria') of the mountain. Even down at the water-side the influence of the proximity of the hill is seen in the spleen rates found in the villages. On the east of the range, where the villages are entirely shut off from sea-breezes, the spleen rates are among the highest possible: 82 per cent. at Kausa, and 93 per cent. at Mumbra.

An attempt that was made ten years ago to solve the problem of house accommodation at Thána by building bungalows for Government officers on one of the northern slopes of the Parsik range, was a complete failure. The bungalows proved as malarious as the villages of the Parsik range had been, and residence in them has had to be given up entirely.

The case of the island of Trombay, forming the south-east corner of Salsette, may next be studied. With its hill of trap-rock, rising to 1,001 feet, whose sides, as they slope down to the sea, are covered with the soil which is a product of the disintegration of the trap, and the edging of salty alluvium along its shores, on which the abundant growth of trees and grass comes to the usual abrupt conclusion, the island of Trombay forms an excellent miniature edition of Salsette. No detailed demonstration of the relation of Malaria to the hill is required; the figures show the closeness of that relationship so well themselves. Villages close to the base of the hill or on the slopes of one of its spurs, have a Spleen Rate of over 50 per cent., which rapidly gives way to smaller rates, ranging from 10 per cent. upwards, at a little distance from the hill. The hamlet of Charai, at the cross-roads, is far enough away to have only 7 per cent. Further north, Chembur, which is still nearer the edge of the tree and grass-covered area, has but 4·2 per cent. But what will be found most significant is that the Spleen Rate of the children of the Mahárs and Bhangis of the Bombay Municipal Refuse Depôt, a little further North still, is *nil*.

People will not, of themselves, build their villages right out in the open, away from the shade of trees, nor will any one build villas or bungalows either. This is only natural, and it must be accepted as an axiom in considering what advice is worthwhile giving. But the one drawback of it, in the case of a malarious tract of country, is well seen here, where the Mahárs and Bhangis of the Refuse Depôt are not only better off in respect of Malaria than the well-to-do artizans of Chembur, but have absolutely no Spleen Rate at all. The reason for it consists in the fact that they cannot choose their place to live in themselves. Their occupation necessitates their living out on the salty alluvium, where there are no trees, and the shortest of grass will hardly grow. Nobody else would live in such a place, and the result is that no other village in the whole of the East of Salsette is like theirs: it is the only one that does not have Malaria in it.

The effect of the sea-breezes is well seen in the case of the village of Trombay itself, which has a Spleen Rate of only 1·3 per cent., in marked contrast to the neighbouring villages inland.

If a general view is taken of the island of Salsette it will be seen that the central hills are surrounded with a ring of villages all having a Spleen Rate of anything between 50 per cent. and 95 per cent. Yeur is the village at the highest altitude that was visited: its rate is 94 per cent. It is very noticeable how, as one passes outwards from the hills to the sea, the Spleen Rate decreases, even where it is only a creek that represents the sea, as in the case of the eastern side of Salsette, while on the western side the villages most completety exposed to the sea-breezes have no Spleen Rate at all. The gradation is in some parts very noticeable; indeed one might in some parts draw lines connecting figures of the same colour and find that they ran parallel with the direction of the range and of the coast-line. Corresponding with the isobars or isotherms on a meteorological chart, these lines of approximately equal spleen intensity might be called "isosplens". Starting near Thána for example, one such isosplen (red) would run from Navpáda southwards through Mulund, Nána, Bhatti, Kanjur, Hariáli and Vikhroli. Another (brown), further from the hills and nearer the creek, would run from Gavhán through Navghar and Bhándup. Another

(orange) would curve round the head of the Thána creek where it contracts, opposite Thána town, to the narrow channel connecting it with the Bassein creek, and would include Itáva, Kalva and Kopri. In this grassy tract of country through which the G. I. P. Railway runs, from Ghatkopar northwards, the hills are too near the creek to leave room for villages so free from Malaria that a green isosplen could be drawn at all. To be able to draw an isosplen in each of the four colours one would have to start at the north-west side of the hills. Here the red would begin at Masha and pass southwards through the hamlets of Dahisar, and through Kákda. South of this the villages close to the hills are actually deserted so that no Spleen Rate can be taken in them at all. The brown isosplen would begin, a little further out from the hills than the other, at Kashi, and pass through Mira, then re-appear first at Devi, a hamlet of Magatna, and then again to pass through Bharodi and Pahadi. The orange would begin at Ghodbandar, a little further north than the others. Here the hills come right down to the creek, and there is, so to speak, a direct conflict of opposing influences. The sea-breezes do exert a marked effect, for Ghodbandar has a much lower Spleen Rate than any other village in Salsette commanded to such a degree by the hills. This orange isosplen would pass through Dahisar, Kanheri, Babái, Poisar and Gári. Outside it, and just before the tree and grass-covered country gives place to the alluvial flats, one might draw a green isosplen of villages that have a Spleen Rate of from five to ten per cent. It would start at Naytodi, and run south through Borivli, Shimpivli, Kandivli, Valnai and Malád. West of this, and fringing the sea-coast, is the long series of villages built on what are more or less islands separated by creeks and mud-flats from the mainland of Salsette, which were mentioned in Chapter I. In most of those villages there is absolutely no Spleen Rate at all. In just one or two is there a rate worth noticing. Thus Dongri village has two hamlets, Tarodi and Pali, that lie just at the base of a small hill, one on each side of it. In their case there is thus a reproduction in miniature of the conditions that bring about malariousness elsewhere, and the one hamlet has a spleen rate of 6·5 per cent., and the other of 5·6 per cent. But, taking those places on the coast as a whole, from Bháyndar on the north down to Bándra on the south, they are found to be all either wholly free from Malaria, or affected by it to a perfectly negligible extent.

Turning to the north-east corner of Salsette, we find very malarious conditions to the north of Thána. Though not quite so badly affected as those nearer the hills, the villages on the Bassein creek have a considerable Spleen Rate; they are too far round the corner, so to speak, to get the benefit of the sea-breezes. There are two villages deserted on account of Malaria here, Mánpára and Kavesar; the inhabitants of the latter have all shifted down to Wágbil on the creek-side. The case of Kolshet, and its hamlet, Tari, the inhabitants of which work the ferry for the Agra road traffic, is instructive. Kolshet is not out of the jungle; it is surrounded with trees and grass, and has a Spleen Rate of 84 per cent. Tari is on the shore, beyond the edge of the trees, just a hundred yards or two down the road, and its Spleen Rate is less than half that of Kolshet.

There now only remains for consideration a limited but important area in the South of the island, bounded on the North by the hills, and on the South by the Bándra creek. For the most part of this area is not under the influence of the hills, but at the north-west and north-east corners of it are two places, Andheri and Ghátkopar, which may be said to be just on the edge of the danger zone. The Spleen Rate of Andheri, 2·7 per cent., would not be noticeable were it not that nowhere south of it is there practically any Speen Rate to record at all. At Ambivli, just north of Andheri, it is 4·5 per cent. A little further still up along the Ghodbandar road we have on the right the deserted village of Mogra, and on the left, on the slope of a grassy hill, a hamlet with a Spleen Rate of 25 per cent.

At Ghátkopar the hill castes, who nowadays mostly work as rice-field labourers, and whose work takes them to fields close to the hills, where they camp out during the rice-harvest, have a Spleen Rate of 73 per cent. The commercial classes, mostly Kacchi Bhattias who go to Bombay daily to their business, but who are resident here all the year round, have a Spleen Rate

of only 5·2 per cent. Their children are not exposed in the way the others are in the Malaria season, and they have every advantage that good housing and good feeding can give; more typical little banias and banianis could hardly be seen. The sudden change which a short distance from the hills makes may be seen by comparing the Spleen Rate of Kirol, where the people mostly work in the rice and grass-lands at the foot of the hills, with that of Old Kurla, down by the head of the Bándra Creek.

It will be seen how free from Malaria are places right away from the hills, such as New Kurla, Kolhekalyan, Vakola (close to Santa Cruz Cantonment), Santa Cruz and Vila Parla.

In attempting to account for that relationship of Malaria to Physiography which is so unmistakeably brought out by the Spleen Census, it is impossible at present to do anything more than surmise that it is the dampness of the ground associated with the constant movement of underground water from the hills towards the sea, and the shelter from the wind provided by the rank growth of trees and grass on the soil formed by the disintegration of the trap, that enable the anophelines to survive so well after the breeding-season, and to persist in numbers long enough into the dry season to become infected, to develop the parasite, and thus to start the cycle of infection of the mosquito by man and of man by the mosquito.

CHAPTER V.

RECOMMENDATIONS.

The subject of practical measures for the diminution of Malaria in Salsette may be considered under two headings, prevention in existing villages, and Prevention in new building areas.

PREVENTION IN EXISTING VILLAGES.—It is here the indigenous population that has to be thought of, both in its own interests and in those of the citizens of Bombay. While, in the abstract, the indigenous population of any malarious táluka of the Thána District is as deserving of protection as that of any other, there is a strong practical reason for devoting special attention to the case of the villagers of Salsette, in the proximity of this highly infected area to the City of Bombay, even if the tendency to suburban building is left out of account.

Without prejudice to anything recommended under the second heading it may at once be said here that in rural Salsette anything like a general attack on the breeding-places of the mosquito is out of the question. We are not here, as in Bombay, dealing with a series of artificial breeding-places, localized over a limited area of very valuable ground, but with natural breeding-places widely distributed over a large tract of country, most of which is of no greater value than such rice or forest-land would be in any other part of the Presidency.

The only series of breeding-places that can be abolished, and should be abolished, is the chain of borrow-pits along the B. B. & C. I. Railway, which, as already pointed out, continue to pour forth mosquitos in October, weeks after all the natural breeding-places in the neighbourhood have dried up. The line runs through a distinctly malarious tract of country from where it leaves Andheri Station to where it emerges on to the alluvial salt-lands at a point between Borivli and Bháyndar Stations, a little to the North of Dahisar village. The worst part of this region is that north and south of Goregaon Station.

The simplest way of dealing with borrow-pits is to run them into one another by a connecting channel, and to have outlets here and there into nullahs, as they occur. But as the Railway Company has already taken up the necessary land for the quadrupling of the line the opportunity should be taken, when construction work is in progress, to abolish the old borrow-pits altogether, and to see that no new ones are left either. Exactly how they shall provide materials for the extension of embankments is a matter for the railway engineers to settle. The only principal that has to be laid down is one which is coming to be well understood in connection with engineering in the tropics, that excavations should be made in such a way that they will drain promptly and completely into the nearest water-course.

It would be well if the due observance of this principle were in future made a regular condition of the acquisition of land by railway companies.

Though, with this exception, *breeding-places* cannot be attacked there is some evidence that it would be worth while to attack the *resting-places* of mosquitos. The extraordinary immunity from Malaria enjoyed by those whose villages are outside the tree and grass-covered area, and are completely accessible to the sea-breezes, is an obvious indication to expose to the sea-breezes as far as possible villages less happily situated. Every encouragement should be given to those who own or occupy the grass-lands of villages to cut the grass early, and keep it cut, in the actual vicinity of both villages and hamlets, and also to cut it early and keep it cut, on the side of any hill which may command a village or hamlet. While people cannot be expected to do without trees to shade their actual houses, the presence of a space free of trees as wide as possible around the village site will tend to promote the necessary ventilation, and the presence of brushwood or undergrowth of any sort in the vicinity of villages should in any possible way be discouraged.

While a great proportion of the adults in malarious places have acquired immunity by slow degrees, or are alive merely as examples of the

survival of the least susceptible, the disease is always in an active condition in the case of the children, whose spleens are the reservoirs which keep up the supply of the infection, and carry it on from one fever season to the next. The diminution of the size of those semi-liquid reservoirs should therefore be the chief aim of our anti-malarial measures, for if one cannot protect the children from the mosquitos the obvious thing to do is to protect the mosquitos from the children. Repeated individual attention to each child with an enlarged spleen is what is necessary; such children are only indirectly infectious, but for practical purposes they should be regarded as if they were directly infectious, and should be looked upon as an immediate source of danger to their neighbours, rich or poor.

The only way to keep up this constant attention to the state of the children's spleens is by means of a Travelling Dispensary. It is not suggested that Salsette should merely be one of the 26 tálukas of the Presidency to which one of the existing travelling dispensaries is sent during the fever season, but that Salsette should have an itinerant Dispensary of its own, worked on special lines, and financed independently of Provincial or of Local Funds. The endowment of such an institution by a private individual, or by the trustees of a charitable fund, would be of benefit not merely to the inhabitants of one town, as in the case of a stationary dispensary, but to the whole of the people of the island who are out of reach of the existing hospitals and dispensaries; moreover, as a preventive institution, its object would be to protect those who are well besides treating those who are actually sick, and so to help the island to become a healthier place for Bombay people to come and live in. To be of any real service the work would have to be carried on the whole year round as each individual spleen would need repeated and systematic attention, and it would accordingly be advisable to provide a caravan for the purpose, in which the Assistant or Sub-Assistant Surgeon in charge could comfortably live even in the monsoon months. One compartment of this would be fitted up as a surgery, and a considerable stock of medicines could be kept in it. The caravan would be drawn by a yoke of bullocks. Two peons would be required. One would accompany the doctor on his visits to villages off the road, and carry the haversack he would take with him; the other would stay behind to look after the caravan. If the doctor wished to take any members of his family with him in the dry weather a small tent could be added to the equipment.

Salsette is fortunate in having its interior encircled by a made road, so that the dispensary could actually circumambulate the island. Experience would show what time was required in order to work the villages once properly, and the period of a perigrination would be fixed. Each time the caravan came round its books would be inspected and its stock made up, by the Civil Surgeon, Thána, or by the Medical Officer of Bándra Hospital, who would have to satisfy himself that the work done was not being confined to a mere distribution of medicines, but that the individual children, whose names were entered in the registers as having been found to have enlarged spleen, were being attended to on each round, and sufficient medicines left for their treatment.

The name of the dispensary, including that of the person whose memory it was desired to perpetuate by the gift of it, could be inscribed on the sides of the caravan.

PREVENTION IN NEW BUILDING AREAS.—If the investigation on which this report is based shows that certain of Mr. Mead's original suggestions are not such as can be carried out it should be remembered that Mr. Mead in his report was the first to suggest a malariological investigation in Salsette in connection with the town-planning he advocated.

Before individual areas are considered it may be well to lay down certain principles which should be adopted where building is being sanctioned. In the first place the leaving of any excavation which can hold water, in connection with the building of houses, should be prohibited by by-law. Wells, again, are very prolific breeding-places of mosquitos and they are not needed in places that have a pipe-water-supply. Their construction should not be sanctioned in such places. Legal powers to order the closing of wells after the introduction of a water-supply would be advantageous; they need not be made

use of in places where there is little Malaria, and where it is not showing signs of increasing. Tanks also are undesirable. To do without them means extra provision, in connection with the pipe-water-supply, of well drained dhobi ghâts, and of places where buffaloes can be washed by their owners, as it does not do to prohibit tanks, and not provide for the due performance of their functions otherwise.

A good deal more can be done to prevent Malaria where the development of a regular garden city is in question than where it is merely a case of giving permission to individual owners of plots to build. It is much easier in the former case, for example, to act upon a recognition of the fact that a combination of trees or bushes with grass tends to make a place far more malarious than it would be with only the trees, or only the grass. But the practicability of preventing this combination should always be kept in mind where new acts, or new by-laws, are being drafted.

Even looking at the matter from the point of view of the safety of the well-to-do, it pays in the planning of a new urban area, to see that a certain standard is kept up for the building of the houses for the poorer classes in the local bazar, and that the promiscuous running up of huts for casual labourers and their families is discouraged.*

The question is to what parts of the island are really suited for residential development may now be considered. It is just because there are such wide variations in the amount of Malaria in the case of places situated at no great distance from one another, and otherwise equally well suited for dovelopment, that it is so well worth while to pay attention to the matter. It is not as though Salsette were, like so many localities in India, simply a malarious tract of country in which one had to make the best of it, and be thankful to find some spots here and there that were rather less malarious and one or two that were distinctly less malarious than the rest. The point about Salsette is that while parts of it are about as malarious as any place could be, there are such considerable areas with practically no malaria at all that one can quite well afford to set up a very high standard indeed. The Central Malaria Committee, looking to the general experience of India, classifies areas as "Healthy" in which the average Spleen Rate is not over ten per cent. In spite of the intense malariousness of parts of the island, Salsette can quite well afford not to call ten per cent. healthy, when it is a question of finding room to house a considerable part of the future suburban population of the city of Bombay. There is space enough without. It is only want of means of communication with Bombay that has in the past so often compelled those who wished to build to content themselves with a plot of ground in a malarious or in only a relatively non-malarious locality. Roughly speaking, it may be said that no Indian who has to go in to Bombay daily will live more than a mile from a railway. Hence it is that healthy tracts have been left undeveloped, while villas, that their owners only occupy for certain months of the year, are clustered in numbers round the stations of the B. B. and C. I. Railway in parts of the island which have, within the last generation or two, become so malarious that the indigenous population has largely disappeared.

The whole question of the development of healthy areas in Salsette is bound up with the question of the possibility of providing efficient means of communication with them. To make it possible for means of communication, such as main roads along which an electric or petrol tramway can be run, to be profitably provided it will be necessary in the future to concentrate attention and funds upon places that really have a future before

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* Thána is one of the two districts of the Presidency that suffer the most from Plague. While touching on the subject of a possible future garden city in Salsette it may not be out of place to note how well it would pay its promoters to make it plague-proof. This does not mean extra expense. It only involves laying out and building the place so that rats will not find it worth while to live in it. Grain would have to be stored, and banias' shops be kept in special buildings not inhabited by human beings, and cattle and human beings would have to live apart. The poorer houses would be built like the inexpensive, but rat-proof houses of Eastern Bengal, where plague, though often introduced, has failed again and again to take root. For details of the subject the Journal of Hygiene, Plague Supplement I, pages 189 to 192, may be referred to.

them. The area receiving attention has hitherto been too extended a one. Town-planning has too often consisted in going after people who have built villas in unsuitable areas, and treating these as if they were the nuclei of future townships. The discouragement of building in unsuitable places is a necessary corollary to the encouragement of it in healthy ones.

Coming to parts of the island in detail, one may say without hesitation that Trombay may be put aside as distinctly unsuitable for development; there is not room for a healthy area between the hill and the mud-flats. Chembur might be considered a possible place, but the area round it is not sufficiently large to make it alone worth special means of communication.

The part of the island between the hills and the Thána Creek, through which the G. I. P. Railway runs northwards from Ghatkopar Station, is one which also is wholly unsuitable for development. The abundant grass lands and the plentiful space around Vikhroli Station led to the selection of Vikhroli by a committee which sat in 1909 as the best site on which to locate the Bombay Municipal Slaughter-house, when that is removed from Bándra, with its allied trades. But the Spleen Rate shows that the scheme would be quite impracticable; there would be such incessant invaliding among the employees, and such a high death-rate among their children. The area is as unsuitable for institutions as it would be for villa residences.

No part of the island—north of Thána—would be suitable for development either, even were it provided with means of access.

Both New and Old Kurla are non-malarious, though there is no room near the Railway Station for building, unless reclamation of flats were undertaken. Ghatkopar is so much on the border-line and so near the danger zone that it is more difficult to give an opinion about it. The part south of the railway is safe enough, and there appear to be some healthy bungalows north of it, but one would certainly deprecate any encouragement of building on the Agra Road.

On the west side of the island the large area round Bháyndar Station in the extreme North, consisting of salt-lands, is unobjectionable from the present standpoint, as it is so free from Malaria. Some Indian commercial men do not find Bháyndar too far from Bombay to live in, but the want of a water-supply is the great hindrance to its development, and there is, unfortunately, no other area suitable for development with which it could combine in managing to afford one.

The next area to be considered is that to the south of this, from Dahisar, between Bháyndar and Borivli Stations, along the B. B. and C. I. Railway to Andheri, which may be considered its southern limit. The Ghodbandar Road runs through it close to the railway, and it is along this road that there has been so much building of bungalows mostly used only in the hot weather, the only reason for building them in this malarious part of the island having been the presence of the railway, on which station after station has been opened for suburban traffic as the bungalows grew in number. Not all parts of this area are equally malarious; that round Goregaon Station is the most so. But the railway runs much too near the central hills of Salsette to allow the neighbourhood of its stations within this area, which is bounded on the East by a line of villages deserted years ago on account of the increasing malariousness of the climate, to be fit for anything that could seriously be called town-planning. It does not do anybody any particular harm that well-to-do people, who can bring their servants and their supplies from Bombay, should elect to live here in the hot weather if it suits them. Their doing so does not involve the planting down of any all-the-year-round population of poorer-class people; that is why it is unobjectionable. But to provide them with roads, water-supply, markets and schools would not only use up part of funds that should be concentrated on the development of more hopeful parts of the island and attract future settlers to the less desirable places; it would also mean that bazaars would form, in which middle-class and poor people would be living all the year round, in a climate which would involve a sick-rate among them and their children higher than there is any need for in the case of people who are to live in Salsette.

There should be no extension northwards of the road already built to the place of pilgrimage at Mandapeshwar. The really important roads in this area are those leading from the railway stations to villages on the west coast; those should continue to be kept up to their full width. There is no objection to the construction of small lengths of accommodation road, at the discretion of the Officer in charge, Salsette Building Sites, for the benefit of existing groups of villas badly needing an exit to the railway. But the principle should be observed that their construction is not to encourage the formation of further bungalows and a bazaar. Requests have been made for an English school at Malád or Borivli, where a certain number of upper-class people do live all the year round. This is contra-indicated on the same principle of non-encouragement. It has also been proposed to utilize part of a charitable fund that exists for the provision of dispensaries in Salsette, to establish one at Borivli. Strictly speaking, the same objection should hold good in this case also, but it would be rather paradoxical to object to the establishment of a dispensary in a place because the neighbourhood was an unhealthy one. Borivli is a little market-town for a great part of north-west Salsette, and a dispensary there would serve a number of existing villages.

There now remain the two healthy areas of Salsette to be considered; that lying to the South of, and beyond the influence of the hills, and that consisting of the islets of the west coast.

As regards the more immediate future the area in the South of Salsette is the more important from the point of view of actual development. It includes the Bándra-Dánda Peninsula, and its boundaries can easily be defined; they form a triangle. Andheri is for the B. B. and C. I. Railway what Ghatkopar is for the G. I. P., the station on the border line, north of which the country very rapidly becomes malarious. No development should ever take place north of the metalled road that runs east from Andheri, and to go too far east along this road would bring one too near the southern end of the hill range. A line is best drawn from Andheri to Old Kurla, to leave out any country within the range of its influence. The base line of the triangle is the Bándra Creek, and the third line is drawn to meet it from Andheri in the direction of Dánda, or of Bándra point.

The flats of the Bándra Creek extend for some little distance into this area, and it is further limited by the existence of the danger zone of the rifle range, south of Santa Cruz Station, and the cantonment of Santa Cruz, near the village of Vakola, but these still leave a considerable area of ground, only parts of which have been built over. The only reason why the rest has not been considered in town-planning schemes, is that it lies more than a mile from the nearest railway station. There is none of it beyond the reach of the water-supply scheme which is being prepared by the Engineer in charge, Salsette Building Sites, so that the only problem is that of means of communication.

The problem would, of course, be most completely solved if it paid the two railways, and if it suited their policy, to have a connecting line between, say Kurla and Andheri, when electrification is brought in. Failing this, such an undertaking as a petrol tramway, to be constructed along one of the future roads within the area, would best meet the difficulty. As regards roads, it has to be remembered that, building apart, the present utter want of means of communication between the two sides of Salsette Island is one that will have to be fulfilled in any case. Strangers to Bándra can hardly believe that there is no way to a town so close as Kurla, and that the Agra Road can only be reached by long and circuitous routes. One of the roads that have been provisionally suggested would continue the Bombay Improvement Trust's new road on the west side of the G. I. P. Railway line from Kurla. Besides running northwards to join the Agra Road it would have a branch crossing the head of the creek and connecting up with the present road that runs westwards from Santa Cruz Cantonment to the station and the Ghodbandar Road. Another suggested road would run westwards from the acute bend of the Agra Road north of old Kurla. Perhaps the most important of all the projected roads is that which would run west of the narrow Ghodbandar Road northwards from the Bándra Municipal Building towards Andheri.

But although it is in connection with this southern area that the attention of the town-planner will be most profitably directed in the meanwhile, no one who has visited the islets of the west coast, of which Mr. Mead writes with such enthusiasm, can fail to see in some of them the most ideal of all sites for a garden city. With those which could most easily be made accessible from the B. B. and C. I. Railway the great difficulty is that of inducing owners or occupiers of the land to allow development to take place. The Khot of Juhu is represented by some twenty odd individuals, so it is small wonder that this beautiful little island, so close to the railway, and so healthfully situated, remains totally undeveloped. Vesava, on the other hand, has already been largely taken up. For a garden city, to be developed as a whole, say by a company, and in connection with which boating and golf throughout the year, could be provided for its sporting residents, the village lands of Malavni would be decidedly the most suitable, could the difficulty be got over of inducing occupiers of agricultural land to allow development; that is to say, development as opposed to the mere dotting about of the peninsula with bungalows on available bits of land. A copy of the village map, showing the tenure of the lands, accompanies this report. There is water-suppy enough to allow building to start, but not to go on far, and it would depend on what was thought now of the future prospects of Malavni whether it was considered advisable to attempt to make provision for its future needs in projecting the water-supply for the South of Salsette. Instructions might meanwhile be given that Government land at Malavni should not be sold for agricultural purposes.

Communication with the railway would have to be provided by petrol or electric tramway along about 4½ miles of road already constructed up to part of its width, between Marva village and Malád Station.

Building-stone and lime are available in abundance locally, and as a brick and concrete factory is about to be built on the coast in the neighbourhood the question of building materials would present no difficulty.

A very little reclamation would link up with Malavni the neighbouring villages of Charkop, Marva and Aksa.

It is not necessary in this report to go into the subject of the suitability of the other village lands of the west coast, which, unlike Malavni, would mostly have to be reached by the bridging of creeks. It would only be after the development of Malavni that their future would have to be thought of.

It is only necessary in concluding this report to point out that it is not alone in Salsette that it is worth while to bear in mind in connection with building sites that relation of physiography to Malaria which is so striking a feature of the climate of the Konkan, but which there has not previously been an opportunity of demonstrating in any detail. His experience of this relation has been of considerable use to the writer already in giving an opinion regarding the different places suggested as the new head-quarters of a district, and there may often be smaller locations to be selected, such as that for a Police post, for example, where a difference of position, quite within the limits of administrative feasibility, might make a very considerable difference to the health and efficiency of those whose duties called them to occupy it.

J. L. MARJORIBANKS
Major, I. M. S.

APPENDIX I.

Table of anophelines, showing places where found, and name of nearest railway station. Stations on the B. B. & C. I. Railway are taken in order going "Up" towards, and stations on the G. I. P. Railway "Down" from Bombay. The record of N. rossii has been omitted from this table. The term "Gauthan" means the actual village site.

M. Barbirostris was found at the following places :—

(Borivli Railway Station).—Larvæ in Railway Borrow pit, mile No. 21 east side; 20 east side; 21-24, 20 west side; No. 24 west side.

DAHISAR.—Larvæ in 2 wells in S. No. 133.

KASHI.—Larvæ in rice field in S. No. 6; well in S. No. 95; rice field in S. No. 3 in the village; adults in cowshed in Gauthan.

MIRA.—Larvæ in rice fields and stream named Dhobidai; Tank named Chari Adults in cowshed in Gauthan.

(Kandivli Railway Station).—POISAR—Larvæ in well of D. L. B. Adults in cowshed in Gauthan.

(Malad Railway Station).—ARE—Adults in cowshed in Gauthan.

CHARKOP.—Larvæ in well in S. No. 12.

KURAR.—Larvæ in well in S. No. 11.

MALAD.—Adults in cowshed in Gauthan.

MALAVNI.—Larvæ in wells in S. No. 12.

VALNAI.—Larvæ in Tank in S. No. 10; and tank named Khandala.

(Andheri Railway Station).—Adults in cowsheds in S. Nos. 19 and 9.

AMBIVLI.—Adults in cowshed.

BANDIVLI.—Larvæ in Tank in S. Nos. 24 and 25; wells in S. Nos. 1, 17 and 19.

CHAKALE.—Larvæ in rice field in S. No. 39.

MAROL.—Adults in cowshed in Gauthan.

MANJAS.—Adults in cowshed in Gauthan.

WYARAVLI.—Adults in hut in Gauthan.

(Bandra Railway Station).—Larvæ in Railway Borrow pit near mile No. 10 east side; well right hand side of St. Joseph's Convent School; Pool in S. No. 241; wells in S. Nos. 235, 241, 223, 204, 189, 203, 240, 198, 197, 239, well in Gauthan; well in Bungalow No. 40; well in Rungari's chawl, well in Municipal School No. 1.

MATMAULI (MOUNT MARY).—Larvæ in wells in S. Nos. 280, 271, 27; 282, 281, 26[8], 246, well of Bungalow No. 81, well of houses Nos. 4 and 38, well in S. Nos. 270, 282, 281, 270.

PALI HILL.—Larvæ in well in S. No. 325.

(Ghatkopar Railway Station).—Adults in cowshed in Gauthan.

KIROL.—Adults in Pacca house in Gauthan.

MAHAL.—Larvæ in wells in S. Nos. 139, 147.

MAHN KHURD.—Larvæ in wells in S. Nos. 88, 91, 38.

MARAVLI.—Larvæ in wells in village.

NAVALI.—Larvæ in rice fields in village.

WADHAVLI.—Larvæ in wells in S. No. 2; Pool in S. No. 1; well in village.

(Vikhroli Railway Station).—HARIYALI—Adults in cowshed.

PACHKOLI.—Larvæ in Pool in the village.

(Bhandup Railway Station).—Adults in cowshed in Gauthan.

(Thana Railway Station).—DHOKALI.—Larvæ in wells in the village. Adults in cowshed in Gauthan.

KAVESAR.—Adults in cowshed in Gauthan.

KOLSET.—Larvæ in well in S. No. 268. Tank in village; wells in S. Nos. 247, 10.

KOPRI.—Adults in cowshed in Gauthan.

MANJIVDA.—Adults in cowshed in Gauthan.

MANPADA.—Larvæ in well in the village.

THANA.—Larvæ in well in B. No. 127; rice field in S. No. 6; well in H. No. 56; well in B. No. 122; well in H. No. 194.

Ny. Fuliginosus was found at the following places :—

(Bhaynder Railway Station).—Larvæ in Railway B. P. near mile No. 22 east side of Railway line of B. B. & C. I. Railway B. P. mile No. 24 west side; mile No. 25 east side.

(Borivli Railway Station).—Larvæ in Railway B. P. near mile No. 23 east side; mile No. 22 west side; mile No. 20 west side; of Railway line of B. B. & C. I. Tank in the same village.

DAHISAR.—Adults in cowshed in Gauthan.

EKSAR.—Larvæ, rice field in S. No. 20; tank in S. No. 202.

KASHI —Adults in cowshed in Gauthan.

MAGATNA.—Adults in cowshed in Gauthan.

MIRA.—Larvæ, Pool in the same village; in S. No. 323; tank in the same village Tank, Chari, in the same village; rice field; Stream, Dhobidai running by the village Adults in cowshed in Gauthan.

(Kandivli Railway Station).—AKARLI—Larvæ in Pool, well in the village. Adults in cowshed and Hut in Gauthan.

KANDIVLI.—Larvæ in Railway B. P. near mile No. 19 east side, west side of the Railway line of B. B. & C. I; tank near S. No. 15; rice field in S. No. 12; Adults in cowshed in Gauthan.

POISAR.—Larvæ in Pool stream in S. No. 5 of the village. Adults in Pucca houses and cowshed in Gauthan.

(Malad Railway Station).—ARE—Adults in hut in Gauthan.

KURAR.—Larvæ in tank in the village in S. No. 3.

MALAD.—Larvæ in Railway B. P. near mile No. 18 east side of B. B. & C. I. Railway; well; rice field in S. No. 106 of the village. Adults in cowshed in Gauthan.

MALAWANI.—Larvæ, well in S. No. 64; tank; wells in S. Nos. 50 and 88; tank to the east of S. No. 99.

WALNAI.—Larvæ in rice field in S. No. 14. Adults in cowshed in Gauthan.

(Goregaon Railway Station).—PAHADI— Adults in cowshed in Gauthan.

GOREGAON.—Larvæ in Railway B. P. near mile No. 17 west side; 16 east side of B. B. & C. I. Railway; tank in S. No. 100; well in S. No. 24 in the village.

(Andheri Railway Station).—Larvæ in Railway B. P. near mile No. 17 east side, 16 west side of B. B. & C. I. Railway; Railway B. P. in S. No. 24; rice field; tank in S. No. 81; rice field in S. No. 81 in the village.

BANDIVLI.—Larvæ in Pools in S. Nos. 41 and 24; well in S. No. 17, and tank in S. Nos. 24 and 25 in the village.

BRAHMANWADA.—Larvæ in well in S. No. 54; tank in the village. Adults in cowsheds in Gauthan.

CHAKALE.—Larvæ in tank in S. No. 48 in the village; and rice field in S. No. 39. Adults in cowsheds in Gauthan.

GONDIVLI.—Larvæ in tank in the village.

KANDIVLI.—Adults in cowshed in Gauthan.

MANJAS.—Adults in cowshed and hut in Gauthan.

MAROL.—Adults in Pacca house, and cowshed in Gauthan.

MOGARE.—Larvæ in Railway B. P. on the B. B. & C. I. line.

OSHIWARA.—Larvæ in wells in S. No. 48 in the village.

(Vila Parla Railway Station).—Larvæ in Railway B. P. near mile No. 16 west side; 15 east side and west side; 14 east side of B. B. & C. I. Railway; tank named Gaon Talav in the village.

(Santa Cruz Railway Station).—Larvæ in rice field in S. No. 377; Railway B. P. near mile No. 13 east side; 12 west side; 13 west side of B. B. & C. I. Railway.

(Bandra Railway Station).—Larvæ in Railway B. P. near mile No. 11 west side; 10 west side; 11 east side; 10 east side of B. B. & C. I. Railway; well in house No. 14; well in S. No. 261; tank in the town.

MATMAULI (MOUNT MARY).—Larvæ in well in the village.

PALI HILL.—Larvæ in well in S. No. 264 in the village.

(Kurla Railway Station).—Larvæ in Pools in S. Nos. 212 and 215; rice fields in S. Nos. 262 and 211, and 253; Railway B. P. on G. I. P. Railway line.

(Ghatkopar Railway Station).—ANIK.—Larvæ in tank in Gauthan; wells in S. Nos. 4, 23; rice field in S. No. 20; Pool in S. No. 75 in the village.

CHEMBUR.—Larvæ in Pool in the village.

GHATKOPAR.—Adults in other building in Gauthan.

MAHUL.—Larvæ in rice fields in S. Nos. 2 and 66; stream east of S. No. 172; Tank south of S. No. 179 in the village.

MAHN KHURD.—Larvæ in stream near S. Nos. 104 and 105 in the village.

MARAWALI.—Larvæ in tank south of Gauthan in the village.

NANALA.—Larvæ in well and rice fields and stream in the village.

(Vikhroli Railway Station).—HARIYALI.—Adults in hut and cowshed in Gauthan; adults in cowshed in Gauthan.

PACHAKOLI.—Larvæ in Pool in the village.

PAWAI.—Larvæ in tank of Pawai south side of the tank.

VIKHROLI.—Larvæ in rice fields; well; Tulsi Tank in the village.

(Bhandup Railway Station).—Larvæ in well in S. No. 31; rice field in S. No. 39 in the village; adults in cowshed in Gauthan.

KANJUR.—Larvæ in Pool; rice field in the village.

(Mulund Railway Station).—Adults in cowshed in Gauthan.

(Thana Railway Station).—BALKUMB.—Larvæ in well in the village.

DHOKALE.—Larvæ in well in the village.

KAVESAR.—Adults in cowshed in Gauthan of Wagbilpada of the village.

KOPRI.—Larvæ in rice field in S. No. 36 of the village. Adults in cowshed in Gauthan.

MANJIVDA.—Adults in cowshed in Gauthan. Larvæ in rice fields of the village.

MANPADA.—Adults in cowshed in Gauthan.

NAVPADA.—Larvæ in rice field in S. No. 42 of the village. Adults in cowshed in Gauthan.

KOLSET.—Adults in cowshed at tari in the village.

THANA.—Larvæ in tank behind House No. 57; well in H. Nos. 131 and 132 tank named Makhwal; well in H. No. 38 in the town.

WADHAWLI.—Larvæ in tank, well in the village; adults in cowshed in Gauthan.

My. Jamesii was found at the following places:—

(Borivli Railway Station).—DAHISAR—Adults in cowshed in Gauthan.

KASHI.—Larvæ in rice field in S. No. 14.

MIRA.—Larvæ in rice field.

(Kandivli Railway Station).—AKURLI.—Larvæ in Dhondlai Tank.

KANDIVLI.—Larvæ in rice field in S. No. 12.

(Andheri Railway Station).—ANDHERI STATION—Larvæ in Railway B. P.

(Bandra Railway Station).—BANDRA—Larvæ in well.

(Ghatkopar Railway Station).—GHATKOPAR—Larvæ in well in S. No. 1.

CHEMBUR.—Larvæ in salt pool.

MAHUL.—Larvæ in well in S. No. 1.

MARAVLI.—Larvæ in rice field.

(Vikhroli Railway Station).—VIKHROLI—Larvæ in Vihad Tank and rice field.

PAWAI.—Larvæ in tank.

(Bhandup Railway Station).—BHANDUP—Larvæ in tank, adults in cowshed in Gauthan.

(Mulund Railway Station).—NAHUR—Larvæ in well and rice field.

(Thana Railway Station).—THANA—Larvæ in well.

WADHAVLI.—Adults in cowshed in Gauthan.

Py. Jeyporiensis was found at the following place :—

(Borivli Railway Station).— MAGATNA—Adults in cowshed in Gauthan.

N. Punctulata was found at the following places :—

(Bhandup Railway Station).—Adults in cowshed in Gauthan.

(Mulund Railway Station).—Adults in cowshed.

(Thana Railway Station).—KOPRI—Adults in cowshed on Gauthan.

Ne. Stephensi was found at the following places :—

(Malad Railway Station).—WALNAI—Adults in cowshed in Gauthan.

(Andheri Railway Station).—GONDIWALI—Larvæ in rice field in S. No. 21.

(Ghatkopar Railway Station).—MARAWALI—Larvæ in Pool.

(Thana Railway Station).—MANPADA—Adults in cowshed in Gauthan.

WADHAVLI.—Adults in cowshed on Gauthan.

My. Listonii was found at the following places :—

(Borivli Railway Station).—EKSAR—Adults in cowshed in Gauthan.

DAHISAR.—Larvæ in well in S. No. 249, and stream in S. No. 24, and rice field.

(Kandivli Railway Station).—POISAR.—Larvæ in well in S. No. 5.

(Malad Railway Station).—KURAR—Larvæ in wells in S. Nos. 11 and 30 and stream in S. No. 5.

CHARKOP.—Larvæ in well in S. No. 12.

WALNAI.—Larvæ in wells in S. Nos. 13 and 19.

(Goregaon Railway Station).—Larvæ in Railway Borrow pit, mile No. 17, west side.

(Andheri Railway Station).—Larvæ in well in S. No. 14.

(Vila Parla Railway Station).—Larvæ in Railway Borrow pit.

(Santa Cruz Railway Station).—Adults in Building.

(Bandra Railway Station).—Larvæ in well behind St. Joseph's Convent School.

MATMAULI—Larvæ in wells in S. Nos. 27, 271 and 282 and a well in Bungalow No. 38.

PALI HILL.—Larvæ in wells in S. Nos. 161 and 325 and in Bungalow No. 6.

(Vikhroli Railway Station).—TIRANDAJ.—Larvæ in pool and stream in Bhui Dongari;

(Bhandup Railway Station).—Larvæ in well in S. No. 23.

KANJUR.—Larvæ in stream.

(Thana Railway Station).—Larvæ in wells in S. Nos. 3 and 127.

YEUR.—Adults in cowsheds in Gauthan.

My. Culicifacies was found at the following places :—

(Borivli Railway Station).—Larvæ in Railway Borrow Pit mile No. 22 and No. 21 west and east side, No. 20 east side, and a well in S. No. 12.

DAHISAR.—Larvæ in wells in S. Nos. 29, 133, 254 and in Railway Borrow pit.

EKSAR :—Larvæ in well.

MIRA :—Larvæ in pool.

(Kandivli Railway Station).—Larvæ in tank near S. No. 15.

AKURLI.—Larvæ in rice field.

POISAR.—Larvæ in rice field, and in well in S. No. 5.

WADHWAN.—Larvæ in well in S. No. 12.

(Malad Railway Station).—Larvæ in wells in S. Nos. 1, 2 and 102.

ARE.—Adults in hut in Gauthan.

DINDOSHI.—Larvæ in well.

KURAR.—Larvæ in well in S. No. 5.

WALNAI.—Larvæ in well in S. No. 13.

(Goregaon Railway Station).—Larvæ in Railway Borrow pit mile No. 14 west side.

(Andheri Railway Station).—Larvæ in rice-field in S. No. 809.

BRAHMANWADA.—Larvæ in well in S. No. 3.

CHAKALA.—Larvæ in well in S. No. 46.

MOGRA.—Larvæ in Sarkari well.

OSHIWARE.—Larvæ in pool in S. No. 48.

(Vila Parla Railway Station).—Larvæ in Railway Borrow pit mile No. 14 east side, and in wells in S. Nos. 241, 245 and 247.

(Santa Cruz Railway Station).—Larvæ in wells, Railway Borrow pit, and in well in S. No. 114.

(Bandra Railway Station).—Larvæ in well in S. No. 261 and in Railway Borrow pit mile No. 10 west side.

PALI HILL.—Larvæ in wells in S. No. 325.

MATMAULI.—Larvæ in wells in S. Nos. 270, 281 and 282.

(Kurla Railway Station).—Larvæ in well.

(Ghatkopar Railway Station).—Larvæ in tank and rice-field in S. No. 185.

VADHAVLI.—Larvæ in well in S. No. 55.

ANIK.—Larvæ in stream.

MAHAL.—Larvæ in stream to the north of S. No. 151.

NANALA.—Larvæ in stream.

(Vikhroli Railway Station).—Larvæ in wells.

HARIYALI.—Adults in cowshed on Gauthan.

TIRANDAJ.—Larvæ in well and stream.

(Bhandup Railway Station).—Larvæ in Railway Borrow pit mile No. 14/15 and in well in S. No. 3 and some others; adults in pucca house on Gauthan.

KANJUR.—Larvæ in well.

(Mulund Railway Station).—Larvæ in well in S. No. 30 and in rice-fields in S. Nos. 16 and other in Gawhanpada; adults in cowshed on Gauthan of Nawagharpada.

NAHUR.—Larvæ in well, pool in S. No. 102 and stream in S. No. 1.

(Thana Railway Station):—Larvæ in wells in house Nos. 3 and 194 and in other wells and stream.

DHOKALE.—Larvæ in well.

MANJIVDA.—Adults in cowshed.

MANPADA.—Larvæ in wells.

NAVPADA.—Larvæ in Railway Borrow pit.

APPENDIX II.

Table of villages in alphabetical order in which anopheline larvæ and adults were found :—

AKURLI.—*My. Culicifacies* larvæ in rice field ; *Ny. Jamesii* larvæ in tank named Dhondlai ; *My. Fuliginosus* larvæ in pool, and well; *My. Fuliginosus* adults, hut and cowshed in Gauthan.

ANDHERI.—*My. Listonii* larvæ in well in S. No. 14, tank in S. No. 81, rice-fields in S. Nos. 81 and 809 ; *My. Barbirostris* adults, cowsheds in S. Nos. 9 and 12.

ANIK.—*Ny. Fuliginosus* larvæ in tank in Gauthan ; *My. Culicifacies* larvæ in stream ; *Ny. Fuliginosus* larvæ in wells in S. Nos. 4 and 23 ; pool in S. No. 75 ; rice-fields in S. No. 20.

AMBIVLI.—*M. Barbirostris* adults, cowshed.

ARE.—*Ny. Fuliginosus* adults, huts and cowshed on Gauthan ; *My. Listonii* adults, cowshed in Gauthan ; *M. Barbirostris* adults, cowshed in Gauthan ; *My. Culicifacies* adults, hut in Gauthan.

BALKUMB.—*Ny. Fuliginosus* larvæ in well.

BANDIVLI.—*M. Barbirostris* larvæ in wells in S. Nos. 1, 17 and 19 ; tank in S. Nos. 24 and 25 ; *Ny. Fuliginosus* larvæ in tank in S. Nos. 24 and 25, pools in S. Nos. 24 and 41, well in S. No. 17.

BANDRA (SEE ALSO MATMAULI AND PALI HILL).—*M. Barbirostris* larvæ in wells in S. Nos. 189, 197, 198, 204, 223, 230, 235, two in 239, 240 and 241, one in Gauthan, one in Bungalow No. 40, one in Municipal school No. 1, one in Rangari's chawl, one at right hand side of St. Joseph Convent's School, and 5 wells, and one pool in S. No. 241 ; *Ny. Fuliginosus* larvæ in well in S. No. 261, one in House No. 14, and one tank ; *My. Culicifacies* larvæ in well in S. No. 261 ; *Ny. Jamesii* larvæ in well ; *My. Listonii* larvæ in well at side of St. Joseph Convent's School ; *M. Barbirostris* adults in cowshed in Gauthan.

BHANDUP.—*Ny Fuliginosus* larvæ in well in S. No. 31 ; rice field in S. No. 39 ; adults in cowshed in Gauthan ; *My. Culicifacies* larvæ in well in S. No. 3, well of khot, well of Mahar ; adults in pacca house on Gauthan ; *Ny. Jamesii* larvæ in tank, adults in cowshed in Gauthan ; *My. Listonii* larvæ in well in S. No. 23 ; *N. Punctulata* adults in cowshed in Gauthan.

BORIVLI.—*Ny. Fuliginosus* larvæ in tank ; *My. Culicifacies* larvæ in well in S. No. 12, and one well.

BAMANVADA.—*Ny. Fuliginosus* larvæ in well in S. No. 54, in tank ; adults in cowsheds in Gauthan ; *My. Culicifacies* larvæ in well in S. No. 3.

CHAKALE.—*M. Barbirostris* larvæ in rice field in S. No. 39 ; *Ny. Fuliginosus* larvæ in rice field in S. No. 39 ; tank in S. No. 48 ; adults in cowsheds in Gauthan ; *My. Culicifacies* larvæ in well in S. No. 46.

CHARKOP.—*M. Barbirostris* larvæ in well in S. No. 12 ; *My. Listonii* larvæ in well in S. No. 12.

CHEMBUR.—*Ny. Fuliginosus* larvæ in pool : *My. Jamesii* larvæ in salt pool.

DAHISAR.—*M. Barbirostris* larvæ in two wells in S. No. 133 ; *Ny. Fuliginosus* adults in cowshed in Gauthan ; *My. Culicifacies* larvæ in wells in S. Nos. 133, 29 and 254 and one well ; *My. Listonii* larvæ in well in S. No. 249, and one well, stream near S. No. 24 ; *Ny. Jamesii* adults in cowshed in Gauthan.

DHOKALE.—*M. Barbirostris* larvæ in wells ; adults in cowshed in Gauthan ; *Ny. Fuliginosus* larvæ in one well ; *My. Culicifacies* larvæ in well.

DINDOSHI.—*My. Culicifacies* larvæ in well.

EKSAR.—*Ny. Fuliginosus* larvæ in rice field in S. No. 20 ; tank in S. No. 202 ; *My. Culicifacies* larvæ in well ; *My. Listonii* adults in cowshed in Gauthan ;

GHATKOPER.—*Ny. Barbirostris* adults in cowshed in Gavthan ; *Ny. Fuliginosus* adults in building in Gauthan ; *My. Culicifacies* larvæ in tank, rice field in S. No. 185 ; *Ny. Jamesii* larvæ in well in S. No. 1.

GONDIVLI.—*Ny. Fuliginosus* larvæ in tank ; *Ne. Stephensi* larvæ in rice-field in S. No. 21.

GOREGAON.—*Ny. Fuliginosus* larvæ in well in S. No. 24, tank in S. No. 100.

HARIYALI.—*M. Barbirostris* adults in cowshed in Gauthan ; *Ny. Fuliginosus* adults in hut and cowshed in Gauthan ; *My. Culicifacies* adults in cowshed in Gauthan.

KANDIVLI.—*Ny. Fuliginosus* larvæ in rice-field in S. No. 12, tank in S. No. 15 ; adults in cowshed in Gauthan ; *My. Culicifacies* larvæ in tank in S. No. 15 ; *Ny. Jamesii* larvæ in rice-field in S. No. 12.

KANJUR.—*Ny. Fuliginosus* larvæ in rice-field, in pool ; *My. Culicifacies* larvæ in well ; *My. Listonii* larvæ in stream.

KASHI.—*M. Barbirostris* larvæ in well in S. No. 95, rice-fields in S. Nos. 3 and 6, adults in cowshed in Gauthan; *Ny. Fuliginosus* adults in cowshed in Gauthan; *Ny. Jamesii* larvæ in rice-field in S. No. 14.

KAVESAR.—*M. Barbirostris* adults in cowshed in Gauthan; *Ny. Fuliginosus* adults in cowshed in Gauthan of Waghilpada.

KIROL.—*M. Barbirostris* adults in pacca house in Gauthan.

KOLSET.—*Ny. Barbirostris* larvæ in tank, wells in S. Nos. 247 and 268, well in S. No. 10 of Tarichapada; *Ny. Fuliginosus* adults in cowshed in Gauthan of Tarichapada.

KONDIVTA.—*Ny. Fuliginosus* adults in cowsheds in Gauthan.

KOPRI.—*Ny. Barbirostris* adults in cowshed in Gauthan; *Ny. Fuliginosus* larvæ in rice-field in S. No. 36, adults in cowshed in Gauthan; *N. Punctulata* adult in cowshed in Gauthan.

KURLA.—*Ny. Fuliginosus* larvæ in rice-fields in S. Nos. 211, 253 and 262, pools in S. Nos. 212 and 215; *My. Culicifacies* larvæ in well.

KURAR.—*M. Barbirostris* larvæ in well in S. No. 11; *Ny. Fuliginosus* larvæ in tank in S. No. 3; *My. Culicifacies* larvæ in well in S. No. 5; *My. Listonii* larvæ in well in S. No. 11, streams in S. Nos. 5 and 30.

MAGATNA.—*Ny. Fuliginosus* adults in cowshed on Gauthan; *Py. Jeyporiensis* adults in cowshed in Gauthan.

MAHUL.—*Ny. Fuliginosus* larvæ in rice-fields in S. Nos. 2 and 66, in tank to the south of S. No. 179, in stream to the east of S. No. 172; *M. Barbirostris* larvæ in wells of S. Nos. 139 and 147; *My. Culicifacies* larvæ in stream to the north of S. No. 151; *Ny. Jamesii* larvæ in well of S. No. 1.

MANJIVDA.—*My. Culicifacies* adults in cowshed; *M. Barbirostris* adults in cowshed on Gauthan; *Ny. Fuligenosus* adults in cowsheds and larvæ in rice-fields.

MALAD.—*My. Culicifacies* larvæ in wells of S. Nos. 1, 2 and 102; *Ny. Fuliginosus* adults in cowsheds on Gauthan, larvæ in well and in rice-field in S. No. 106; *M. Barbirostris* adults in cowshed on Gauthan.

MALAVNI.—*M. Barbirostris* larvæ in well in S. No. 12 and other well; *Ny. Fuliginosus* larvæ in tank to the east of S. No. 99, and in wells of S. Nos. 50, 64 and 84.

MARAWALI.—*M. Barbirostris* larvæ in well; *Ny. Fuliginosus* larvæ in tank; *My. Jamesii* larvæ in rice-field; *Ne. Stephensi* larvæ in puddle.

MATMAULI (MOUNT MARY OR BANDRA HILL).—*M. Barbirostris* larvæ in wells of S. Nos. 27, 271, 282, 270, 281, 282, 270, 246, 268, 281, 280, and in wells of houses Nos. 4, 38 and 81; *Ny. Fuliginosus* larvæ in well; *My. Culicifacies* larvæ in wells of S. Nos. 281, 282 and 270; *My. Listoni* larvæ in wells of S. Nos. 27, 271, 282 and a well of bungalow No. 38.

MANJAS.—*M. Barbirostris* adults in cowshed on Gauthan; *Ny. Fuliginosus* adults in cowshed and hut of Gauthan.

MAHN KHURD.—*M. Barbirostris* larvæ in wells of S. Nos. 58, 91 and 88; *Ny. Fuliginosus* larvæ in stream.

MANPADA.—*M. Barbirostris* larvæ in well; *Ny. Fuliginosus* adults in cowshed of Gauthan; *My. Culicifacies* larvæ in well; *Ne. Stephensi* adults in cowshed on Gauthan.

MAROL.—*M. Barbirostris* adults in cowshed on Gauthan; *Ny. Fuliginosus* in house and cowshed on Gauthan.

MIRA.—*M. Barbirostris* larvæ in Dhobidai stream and Chari Tank and in rice-fields, adults in cowshed on Gauthan; *Ny. Fuliginosus* larvæ in puddles and tank, adults in cowsheds on Gauthan, in streams, in tank and in rice-field; *My. Culicifacies* larvæ in Sarkari well, puddle and rice-field; *Ny. Jemesii* larvæ in rice-field; *My. Listoni* larvæ in rice-field.

MULUND.—*Ny. Fuliginosus* adults in cowsheds on Gauthan; *My. Culicifacies* larvæ in well in S. No. 30 and in rice-field in S. No. 16, adults in cowshed on Gauthan.

NAHUR.—*My. Culicifacies* larvæ in well, stream in S. No. 1, puddle in S. No. 102; *Ny. Jamesii* larvæ in well and rice-field.

NAUALA.—*M. Barbirostris* larvæ in rice-fields; *Ny. Fuliginosus* larvæ in rice-fields, in well and in stream; *My. Culicifacies* larvæ in streams.

NAVPADA.—*Ny. Fuliginosus* larvæ in rice-field in S. No. 42, adults in cowsheds on Gauthan; *N. Punctulata* adults in cowshed on Gauthan.

OSHIVRA.—*Ny. Fuliginosus* larvæ in well in S. No. 48; *My. Culicifacies* larvæ in puddle in S. No. 48.

PACHAKOLI.—*M. Barbirostris* larvæ in puddle; *Ny. Fuliginosus* larvæ in puddle.

PAHADI.—*Ny. Fuliginosus* adults in cowshed on Gauthan.

PALI HILL.—*M. Barbirostris* larvæ in well in S. No. 325; *Ny. Fuliginosus* larvæ in well in S. No. 264; *My. Culicifacies* larvæ in wells in S. No. 325; *My. Listoni* larvæ in wells in S. Nos. 6, 161 and 325.

PAVAI.—*Ny. Fuliginosus* larvæ in tank; *Ny. Jamesii* larvæ in tank.

POISAR.—*M. Barbirostris* larvæ in well, adults in cowshed on Gauthan; *Ny. Fuliginosus* larvæ in puddle and in stream S. No. 5; adults in house and cowshed on Gauthan; *My. Culicifacies* larvæ in well in S. No. 5 and rice-field; *M. Listoni* larvæ in well in S. No. 5.

SANTA CRUZ.—*Ny. Fuliginosus* larvæ in rice-field in S. No. 377; *My. Culicifacies* larvæ in well in S. No. 114 and other; *My. Listoni* adults in building in Gauthan.

THANA.—*M. Barbirostris*, larvæ in wells in S. Nos. 56, 122, 194, 127, and in rice-field in S. No. 6; *Ny. Fuliginosus* larvæ in wells in S. Nos. 38, 132, 131, and in tanks one named Mahhamel and the other behind H. No 57; *My. Culicifacies* larvæ in wells in Patawai No. 3, in H. No. 194 and some others and in stream; *Ny. Jamesii* larvæ in well; *My. Listoni* larvæ in wells in S Nos. 127 and 3.

TIRANDAJ.—*My. Culicifacies* larvæ in well and stream; *My. Listoni* larvæ in stream and puddles.

VADHVAN.—*My. Culicifacies* larvæ in well in S. No. 12.

VALNAI.—*M. Barbirostris* larvæ in tank called Khandala and in tank in S. No. 10; *Ny. Fuliginosus* larvæ in rice-field in S. No. 14, adults in cowshed on Gauthan; *My. Culicifacies* larvæ in well in S. No. 13; *My. Listoni* larvæ in wells in S. Nos. 13 and 19; *Ne. Stephensi* adults in cowshed on Gauthan.

VIKHROLI.—*Ny. Fuliginosus* larvæ in well, tank, and rice-fields; *My. Culicifacies* larvæ in wells; *My. Jamesii* larvæ in rice-field, Vihad Tank and other tank.

VILA PARLA.—*Ny. Fuliginosus* larvæ in tank; *My. Culicifacies* larvæ in wells in S. Nos. 245, 241 and 247.

WADHAVLI in TROMBAY.—*M. Barbirostris* larvæ in puddle and in well in S. No. 2; *Ny. Fuliginosus* larvæ in well and tank; *My. Culicifacies* larvæ in well and in stream in S. No. 55.

WADHAVLI near THANA.—*Ny. Fuliginosus* adults in cowshed on Gauthan; *Ny. Jamesii* adults in cowshed on Gauthan; *Ne. Stephensi* adults in cowshed on Gauthan.

WYARAWALI.—*M. Barbirostris* adults in hut on Gauthan.

YEUR.—*My. Listoni* adults in cowsheds on Gauthan.

W. Wilkinson

APPENDIX III.

Apparatus used for the Capture and Development of Larvæ.

The Salsette enquiry afforded a pretty extended opportunity for testing the relative usefulness of different forms of apparatus that have been used or suggested for use elsewhere, and finding out the best way of using those that were found to be really practical. The following were found the best to use:—

DR. BENTLEY'S WELL-NET.—This is described in Dr. Bentley's Report on Malaria in Bombay. A substitute, which does not fold up like the original, was obtained for the Salsette investigation through the Malaria Assistant to the Health Officer, Bombay Municipality, from a Borah named Hassan Ali Abdul Ali. The well-net is absolutely indispensable, and even with its use larvæ will be missed if Dr. Bentley's directions about inverting the net and washing it are not followed in every case.

BUCKET.—This is needed to bring up some of the water of each well to wash the larvæ out of the net. If the rest of the kit is to be carried in it the bucket should be as large as possible; otherwise, the smaller it is the better.

ENAMELLED FRYING-PAN.—This was introduced by Dr. Bentley merely to wash the net, but in the Salsette enquiry it proved to be by far the most useful vessel for catching larvæ in tanks and streams, as the width of the sweep one can give with it enables such a large surface of water to be examined at a time, and as it can stand rough usage so well, when the bottom of a stream is being examined.

LONG ENAMELLED SPOON.—This is chiefly of use in skimming the larvæ from the water in the frying-pan, but it is also useful in examining hoof-prints and other small hollows containing water.

ENAMELLED MUG.—The two latter articles suffice for nearly every open place but a mug is needed for work in rice-fields and places where long grass stands in water.

QUININE BOTTLE.—Both for carrying in the field and for keeping the larvæ in afterwards to hatch out, the most useful bottles to use are ounce-of-quinine bottles, which are obtainable easily in the bazaar. These are cylindrical bottles of seven fluid ounce capacity, and the most suitable ones are those which have a broad flange on the lip. Each should be fitted with a string round the neck to which to fix another loop of string, like the handle of a basket, to carry the bottle by. The cap of the bottle is best made of a little square of coarse *dangri* or *khadi* cloth, tied to the string on the neck by a thread a couple of inches long. This cloth is of open texture, and allows free access of air. To the upper surface of the cap, near one edge, should be sewn a loop of silk elastic. If the cap is laid on the mouth of the bottle it can be fixed on in a second by laying the forefinger of the left hand, which holds the bottle, on the insertion of the loop, against the neck, and slipping the loop down over the mouth with the right hand. The bottles are carried in the field with the caps hanging down. Each is capped as soon as it is filled, without the aid of any string. A good rule to make is that, once it is capped, no bottle is to be opened, except by the Malaria Officer himself.

Each bottle has a label, bearing simply a serial number, in English and in the vernacular, which is written on it when the day's batch of bottles is being issued, and which corresponds with a number in the register. The bottles are carried in a wooden box or tray with compartments, which has a handle rising from the middle compartment, and as each is filled and capped the searcher enters the number in the margin of his note-book, and opposite this makes a note of the kind of collection of water the larvæ were taken from, and the village survey number, or other means of identification of the place. At the end of the morning's or evening's search the bottles are returned to the laboratory, and the notes copied from the searcher's note-book into the register, opposite the serial numbers. If carbons are used with the note-books individual searchers need not attend the laboratory; they tear out the pages and send them in with the bottles. The bottles are examined as soon as the Malaria Officer has time to attend to them and then write up his part of the register. In Salsette the register was kept somewhat in the following fashion:—

Serial number.	Date.	Rice-field.	Well.	Tank.	Cistern.	Puddle.	Saltpan.	Railway Borrow Pit.	Stream.	Swamp.	Locality.	Ny. fuliginosus.	N. rossii.	My. culicifacies.	Ny. Jamesii.	My. listonii.	M. barbirostris.	Ne. stephensi.	Remarks.	Identified by larvæ or imago.
457	5th Oct. 1912	...	1	...	...	...	...	...	...	...	S. N. 271 Mount Mary.	...	...	...	...	1	1	...	Listonii has branched frontal hairs as in Bentley.	l = I
458	Do. ...	...	...	1	...	...	...	...	...	...	Gauthan of Akurli.	1	...	...	...	...	...	...	.....	b = L I

As the examination of the contents of each bottle is finished and the result registered the number on its label is heavily crossed out with blue pencil. The peon in attendance, who recognizes this marking, removes the bottle, rinses it out, and fixes on a new blank label, and the bottle, with its cap and elastic hanging from it, is placed in the stock for re-issue with a fresh serial number.

Although it pays to keep the specimens for several days, to let as many adults develop as possible, it is seldom worth the trouble to change the water in the bottles; as a rule if larvæ will not develop in their own water they will not do so in any other. In Salsette it was found that a greater proportion of specimens yielded adults when kept standing in the dry weather after the monsoon than during the wet weather itself.

However many bottles have accumulated on the shelves, with only the numbers on them to distinguish them, if a rule is observed that only one bottle is allowed to have its cap off at one time no mistake in identity can occur, even if the Malaria Officer is called away in the middle of examining larvæ or adults taken out of a bottle.

A stylo pen pipette is useful for taking out larvæ for examination under the microscope.

When adults have developed in a bottle, if it is desired to mount them without chloroforming them *in situ*, which would wet them, and kill the remaining larvæ in the bottle, they may be transferred to a dry bottle in the following way; to let any escape should be considered bad technique:—

Hold the wet bottle in the left hand, with the forefinger and thumb forming a ring round the neck, and pressing the margins of the cap against the glass. Slip off the elastic band inserted on the cap. Invert a dry bottle, with its cap hanging off, over the wet one, and clasp both bottles with the right hand. With the left pull off the cap of the wet bottle sideways from between the two mouths, and let it hang. The mosquitos will fly up into the dry bottle. If any are sluggish the lower bottle may be bumped on the table, or tilted so that the water touches their hind legs. When all have flown up and been counted lay the cap of the dry bottle on the palm of the left hand, slip the still inverted bottle rapidly on to it, and adjust the elastic before turning the bottle up. Then copy the number of the wet bottle on to the label of the dry.

A window-sill is a convenient place for this dry bottling.

The following directions to those who are to collect the larvæ are only for the using of the kit described above, and are intended to supplement the general instructions which are usually given. The use of Dr. Bentley's well-net is described on page 69 of his report, so directions for this are not given here.

Directions given to Searchers.

For field work the following should be taken:—A well-net, a bucket, a frying-pan, a long spoon, a mug, a boxful of quinine bottles and a note book with carbon sheet and pencil. The mug, the spoon and pan should each have a loop of string fixed to its handle. When a tank or stream is to be examined the pan, the spoon and a bottle, with its cap hanging down, should be taken from the cooly, and the spoon and the bottle hung from the third and fourth fingers of the left hand. Nothing is to be put on the ground. The water should be considered to be in three layers or levels, the surface, at which the larvæ may be feeding, the middle, in which they may be concealed in green weed, and the bottom, on which they may be resting. The surface should first be skimmed with the pan. After each sweep the pan should be held at rest, and examined, plenty of time being given to allow the larvæ to come to the surface. If any are seen the pan should be grasped at the side opposite the handle with the thumb and first two fingers of the left hand, while the spoon is taken off the third finger with the right hand. Held like a pen, it is used to skim the larvæ off the surface and pour them into the bottle which hangs from the little finger.

If the bottle gets too full of water before there are many larvæ in it the water may be partly poured away by bridging the mouth of it with the forefinger at one side, and cautiously tilting the bottle in that direction. The water runs away under the finger, while the larvæ at the surface are not disturbed.

The "middle layer" of the water of the tank or stream should then be examined, if there is green weed present, piece after piece of it being brought up in the pan. If no larvæ come out of the weed to the surface of the water in the pan the weed should be squeezed like a sponge with the hand under water.

Lastly, the bottom should be examined, and stirred up with the pan, the surface water being then skimmed for the larvæ that may have come up when disturbed.

The cooly may meanwhile employ himself in searching for larvæ with the mug.

The larvæ of not more than one tank, well or stream may be put into one bottle, though a chain or rice-fields or borrow-pits may be considered as one. When enough larvæ have been secured the cap is to be fixed on with the elastic, and the bottle given back to the cooly. The number of the bottle, and a short description of the piece of water from which the larvæ were taken, with the name of the village, and if possible the survey number, should be entered in the note-book, before the cooly replaces the bottle in its compartment of the box.

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OF THE

THIRD MEETING

OF THE

GENERAL MALARIA COMMITTEE

HELD AT

MADRAS

November 18, 19 and 20, 1912.

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1. President's Address.
2. Report of officer in charge, Central Malaria Bureau.
3. *Papers of an epidemiological character.*
   (*a*) Madras.—Malaria in the Madras Presidency. Notes on the statistics of the last ten years—*Captain J. H. Horne, I.M.S.*
      (1) Malaria in Bengal.—*Major A. B. Fry, I.M.S.*
      (2) Note on an enquiry into malaria and mosquitos in the Kashmir Valley.—*Lieutenant-Colonel and Mrs. Adie.*
   (*b*) Some problems presented by Malaria in Bengal.—*Dr. C. A. Bentley.*
   (*c*) Central Provinces.—Results of malaria investigation in the Central Provinces.—*Major T. G. N. Stokes, I.M.S.*
   (*d*) Delhi.—Some points of interest in the malarial survey of the site of the new Imperial Delhi.—*Captain E. C. Hodgson, I.M.S.*
   (*e*) The endemic malaria of the Jeypore Agency Estate, Madras.—*Major E. L. Perry, I.M.S.*
   (*f*) A note on the mosquitos of the United Provinces.—*Major J. D. Graham, I.M.S.*
   (*g*) The breeding of mosquitos.—*Rai Kailas Chandra Bose Bahadur, C.I.E.*
   (*h*) A new conception regarding malaria.—*Dr. C. A. Bentley.*
4. *Papers of a medical character.*
   (*a*) The relation of malaria fever to kala azar.—*Rai Kailas Chandra Bose Bahadur, C.I.E.*
   §(*b*) The Haemolytic action of Quinine Salts with suggestions regarding the etiology and treatment of Black-water fever.—*Major A. C. MacGilchrist, I.M.S.*
   §(*c*) Discussion of some important and practical points regarding the pharmacological action and uses of Quinine.—*Major A. C. MacGilchrist, I.M.S.*
   §(*d*) The diagnosis of latent malaria.—*Captain H. W. Acton, I.M.S.*
5. *Papers relating to the prevention of Malaria.*
   (*a*) Working of a scheme for the prevention of malaria in Bombay.—*Dr. J. A. Turner.*
   (*b*) Quinine propaganda in Bengal.—*Dr. C. A. Bentley.*
   (*c*) Quininisation of school children in the United Provinces.—*Major J. D. Graham, I.M.S.*
   (*d*) Some larvæcides and natural enemies of mosquitos in Southern India.—*H. C. Wilson, Esq.*
   (*e*) Anti-malarial operations in the United Provinces.—*Major J. D. Graham, I.M.S.*
   (*f*) Epidemiological and preventive researches of the Association for malarial studies in Italy during 1910.—*Major N. P. O'Gorman Lalor, I.M.S.*

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6. *Progress Reports on stegomyia operations.*

(*a*) Distribution and habits of stegomyia and allied species of mosquitos in Bombay.—*Major W. G. Liston and Sub-Assistant Surgeon Akula.*

(*b*) Distribution and habits of stegomyia in Karachi.—*Dr. Mhaskar.*

(*c*) The yellow fever mosquito.—*Mr. F. M. Howlett.*

(*d*) The breeding places of *phlebotomus.*—*Mr. F. M. Howlett.*

(*e*) Stegomyia fasciata.—*Mr. F. M. Howlett.*

(*f*) Progress Report of the stegomyia survey in Calcutta.—*Major A. C. MacGilchrist, I.M.S.*

(*g*) Notes on the stegomyia survey in Madras.—*Captain J. H. Horne, I.M.S.*

(*h*) Progress report on the stegomyia survey in Rangoon.—*Major N. P. O'Gorman Lalor, I.M.S.*

7. *Protozoal Diseases,* particularly those due to Trypanosomes.—*Captain F. P. Mackie, I.M.S.*

8. *Paper relating to Kala Azar.*

(*a*) Paper by the Committee investigating the disease.

(1) Progress Report on Kala Azar.—*Captain F. P. Mackie, I.M.S.*

(2) Is Kala Azar of animal origin?—*Captain W. S. Patton, I.M.S.*

(3) Report of the Kala Azar Committee.—*The Hon'ble Surgeon General W. B. Bannerman, I.M.S.*

(4) Further observations on the development of the parasite of Kala Azar in the bed bug.—*Captain W. S. Patton, I.M.S.*

(5) Paper on Kala Azar.—*Dr. V. T. Korke.*

(*b*) Kala Azar, its distribution and probable mode of infection.—*Lieutenant-Colonel C. Donovan, I.M.S.*

(*c*) An account of an investigation of endemic Kala Azar in the plains of Assam.—*Captain T. C. McCombie Young, I.M.S.*

9. The body louse as a disease carrier.—*Captain F. P. Mackie, I.M.S.*

10. Etiological relationship of seven days fever.—*Major N. P. O'Gorman Lalor, I.M.S.*

11. A short note on the relation between the seasonal birth and death rate curves.—*Major J. C. Robertson, I.M.S.*

President.

The Hon'ble Surgeon-General Sir Pardey Lukis, K.C.S.I.,
M. D., F.R.C.S., I.M.S.,
Director-General, Indian Medical Service.

Delegates.

India

1. Major J. C. Robertson, I.M.S.,
Sanitary Commissioner with the Government of India.

2. Captain A. G. McKendrick, I.M.S.,
Secretary to the Director-General, I. M. S., (Sanitary).

3. Captain E. C. Hodgson, I.M.S.,
In charge Malaria Bureau, Central Research Institute.

4. Captain F. P. Mackie, I.M.S.,
On special duty, Kala Azar Enquiry.

5. Dr. V. T. Korke,
On special duty, Kala Azar Enquiry.

Ceylon

6. Dr. G. J. Rutherford, M.R.C. S., L.R.C.P.,
Assistant Principal Civil Medical Officer, Ceylon.

7. Dr. W. Marshall Philip, M.B.,
Municipal Medical Officer of Health, Colombo.

Madras

8. The Hon'ble Surgeon-General W. B. Bannerman, C.S.I., I.M.S.,
Surgeon-General with the Government of Madras.

9. Captain W. A. Justice, I.M.S.,
Sanitary Commissioner, Madras.

10. Lieutenant-Colonel C. Donovan, M.D., I.M.S.,
Surgeon, 4th District, Madras.

11. Major T. S. Ross, I.M.S., Special Malaria Officer, Cuddapah.

12. Captain J. H. Horne, I.M.S., Special Malaria Officer, Madras.

13. Captain W. S. Patton, I.M.S.,
On special duty, Kala Azar Enquiry.

14. H. C. Wilson, Esqr.,
Piscicultural Expert, Madras.

Bombay

15. Major H. A. Forbes Knapton, I.M.S.,
Officiating Sanitary Commissioner, Bombay.

16. Major W. G. Liston, M.D., I. M. S.,
Director, Bombay Bacteriological Laboratory.

17. Major F. H. G. Hutchinson, M.B., I.M.S.,
On special duty, Experimental Sewage Installation, Poona.

18. Dr. J. A. Turner, M.D., D.P.H.,
Executive Health Officer, Bombay Municipality.

19. Dr. Mhaskar,
On special duty, Stegomyia Survey, Karachi.

Bengal

20. Major L. Rogers, C.I.E., I.M.S.,
Professor of Pathology, Medical College, Calcutta.

21. Major W. W. Clemesha, I.M.S.,
Sanitary Commissioner, Bengal.

22. Major A. B. Fry, I.M.S.,
Deputy Sanitary Commissioner, Bengal.

Bengal—*contd.* ...
23. Dr. C. A. Bentley,
Special Deputy Sanitary Commissioner, Bengal.
24. Major A. C. MacGilchrist, I.M.S.,
on Special Duty, Stegomyia Survey.
25. Rai K. C. Bose Bahadur, C.I.E,
Private Medical Practitioner, Calcutta.

United Provinces.
26. Major S. A. Harriss, I.M.S.,
Sanitary Commissioner, United Provinces.
27. Major J. D. Graham, I.M.S.,
Special Malaria Officer, United Provinces.

Punjab ...
28. Lieutenant-Colonel E. Wilkinson, I.M.S.,
Sanitary Commissioner, Punjab.
29. Major E. L. Perry, I.M.S.,
Offg. Chief Malaria Medical Officer, Punjab.

Burma ...
30. Major C. E. Williams, I.M.S.,
Sanitary Commissioner, Burma.
31. Major N. P. O'Gorman Lalor, I.M.S.,
Deputy Sanitary Commissioner, Burma.
32. Dr. J. B. Stephens,
Municipal Health Officer, Rangoon.

Bihar and Orissa
33. Captain W. C. Ross, I.M.S.,
Officiating Sanitary Commissioner, Bihar and Orissa.

Central Provinces
34. Major T. G. N. Stokes, I.M.S.,
Sanitary Commissioner, Central Provinces.
35. Major L. W. S. Oldham, R.E.,
Sanitary Engineer, Central Provinces.

Assam ...
36. Captain T. C. McCombie Young, I.M.S.,
Deputy Sanitary Commissioner, Assam.

37. The Hon'ble Sir Harold Stuart, K.C.V.O., C.S.I.,
Member of Council, Madras.

38. The Hon'ble Mr. R. C. C. Carr,
Offg. Member, Board of Revenue, Madras.

39. The Hon'ble Mr. Lionel Davidson,
Offg. Secretary to Government of Madras.

40. Professor F. M. Howlett,
Imperial Pathological Entomologist, Pusa, Bengal.

41. Captain F. W. Cragg, I. M. S.,
Assistant Director, King Institute, Madras.

FIRST DAY.—NOVEMBER 18, 1912.

The third meeting of the General Malaria Committee opened its session at the Council Chamber, Fort St. George, Madras.

The President addressed the delegates as follows:—

Gentlemen, in welcoming you to this our third conference, I am pleased to be able to report that during the past twelve months there has been satisfactory progress towards that unification of aim in our anti-malarial policy and the training of practical workers upon which I laid such stress in my speech at Bombay last November. This aim has been kept steadily in view during the first year, and our present policy, which, without interfering in details, has for its goal practical anti-malarial work, is largely the outcome of the deliberations of your Central Scientific Committee and of the Scientific Advisory Board which has been inaugurated under the auspices of the Indian Research Fund. And here I wish to acknowledge our thanks to Sir Harcourt Butler, for all he has done to advance the cause of practical sanitation, and to express our warm appreciation of the cordial co-operation of Sir Ronald Ross who has honoured us by agreeing to act as a Consulting Member of the Advisory Board. As regards increasing our staff of practical workers I may note that our organisation has been materially strengthened by the appointment of special malarial officers in Madras, Bengal, the United Provinces, the Central Provinces, the Punjab and Burma. We have also modified the system of malarial classes so as to make them more practical, at the same time altering the composition of the class and increasing its numbers. In 1910, 24 medical officers and subordinates were trained, but in 1911, only 18, and all of these were from the civil side. During 1912 however we trained 57 candidates of whom 27 were in civil and 30 in military employ and we are now prepared to admit 16 military and 16 civil officers to each class or a total of 64 per annum Thus we are not only co-operating with the sister service by providing the military authorities with trained officers for regimental and cantonment purposes, but we are preparing young Indian Medical Service officers whilst they are still in military employ, for anti-malarial work in their districts should they later on become Civil Surgeons. We attach considerable importance to this because experience has shown us that Civil Surgeons experience great difficulty in obtaining the necessary leave to attend these classes. In conformity too with the practical aspect of our policy we have arranged that the class now under training should meet at Delhi where Captain Hodgson, who is acting for Major Christophers, in charge of the Malarial Bureau, is conducting a detailed malarial survey of the Imperial Enclave. By so doing his pupils will have actually participated in a malarial survey and will be fully equipped for carrying on similar work in their own districts later on. There is only one point on which I regret I am unable to report progress, and that is as regards our publication "Paludism." I am very sorry, gentlemen, that my appeal on this subject last year has fallen upon deaf ears. We have received very little support in the way of contributions and we are seriously considering the advisability of substituting for "Paludism" a Journal of Indian Research with special sections for Malaria, Medical Entomology, Protozoology, etc. Such a journal would we think serve a useful purpose and in it we could publish many of the short papers of great interest which come up to us from time to time but which are not of sufficient length to justify publication as separate "Scientific Memoirs."

Regarding yellow fever which as a mosquito-borne disease forms one of the subjects for our consideration, you have all of you heard of the preventive measures which have been taken by Government and of the progress which has been made in the "stegomyia" survey as recommended in the sixth resolution of last year's conference. The object of this survey appears to have been misunderstood in certain quarters, indeed one paper asks what is the use of a survey of a mosquito which we already know to exist in large numbers all along our coasts. The writer has however overlooked the fact that although we know that this mosquito exists in large numbers, we have not, or had not until recently, any exact information as to its actual breeding places, habits, etc. The observations of Boyce in the West Indies and of Howlett in this country show that, at any rate in towns, the extermination of the "stegomyia" or its reduction to non-dangerous numbers is

theoretically possible, and our present object is to prove whether or no this extermination is really practicable. So far as the preliminary reports go, they are very encouraging. For instance the survey at Rangoon shows that *Stegomyia Fasciata* is essentially a domestic mosquito and that it breeds in small collections of stagnant water such as bottles, tins, saucers under the legs of cupboards or meat-safes, etc., within house limits; it is clear that its extermination is largely a question of house sanitation and not one involving extensive drainage operations. One of the most important duties of the Scientific Advisory Board, after allotting money for these stegomyia surveys, was to advise Government as to the distribution of the sum of five lakhs which had been placed at the disposal of the Research Fund for anti-malarial purposes. The principle which guided us in making our recommendations was as far as possible to recommend expenditure only on schemes which preliminary investigation had shown were likely to accomplish definite results. Under this head come the grant-in-aid of Rs. 50,000 to Bombay for carrying out the anti-malarial operations proposed by Bentley in Bombay City, and the sum of Rs. 1,80,000 to the United Provinces for anti-malarial measures in Saharanpur, Nagina, and Kosi, where preliminary malarial surveys by Robertson and Grahom have shown that the mitigation of malaria in these towns was perfectly feasible at no prohibitive cost. We have also allotted certain sums for preliminary investigations in Sind and Ennore near Madras.

The uselessness of spending money on anti-malarial measures without preliminary investigations was forcibly brought home to me in the course of one of my recent tours. In a certain town which shall be nameless but which had been suffering severely from malaria, I found the municipal authorities expending large sums of money in filling up all the tanks which contained dirty or evil-smelling water, whilst all those which contained clear water and which were of course the only ones in which dangerous anophelines would breed, were left severely alone. I need hardly point out that if this mistake had not been brought to their notice, the result of their proceedings would not only have been a shocking waste of money, but the failure of the project would have been used later on as an argument to show the uselessness of anti-malarial operations.

All the schemes I have mentioned so far are for urban districts only, but you must not imagine that the very important question of malaria in rural areas has been neglected; on the contrary it has our most earnest attention, and in this connection I must allude to the most excellent work done by Stewart and Procter in Lower Bengal. They have shown that a close correlation exists between over-vegetation and intensity of malaria—in which respect they are in close agreement with the findings of Watson in Malaya. At the suggestion of the Government of India, the Government of Bengal has taken up the matter and it is proposed to allot a considerable sum of money to carrying out an extensive experiment of jungle clearing in the neighbourhood of inhabited areas. Should this experiment prove a success, we shall have at our disposal one method at least of improving the conditions obtaining in small villages, especially in the deltaic area. But although this method is likely to be useful in flat country, it is doubtful whether it will avail in hilly tracts, especially in hilly tracts intersected by ravines. Watson has found it useless in Malaya, and Kenrick has arrived at similar conclusions in the Central Provinces. Major Perry too, in his paper which is for discussion to-day, goes carefully into the practical question of jungle-clearing in the hilly tracts of this Presidency and shows that, whereas on the 3,000 feet plateau jungle-clearing produces little obvious effect, on the 2,000 feet plateau the conditions are different and the proper clearing of jungle gives hope of the practical eradication of malaria.

There are many other ways in which we may deal with malaria in rural areas. First and foremost amongst these I would mention what has been aptly termed "water-tidiness," that is to say the filling up or draining of all pools which might be potential mosquito breeding grounds and the clearing and trimming of the edges of all tanks, for at least half a mile round each village, so as to deprive the mosquito larvæ of the protection afforded by weeds against their natural enemies.

The next most important step is the stocking of pools and tanks with mosquito-destroyers should these be absent. This need not be an expensive or troublesome task. I am not suggesting the importation of the much vaunted "millions" from Barbadoes, and I am aware that during the past few years much money has been wasted by the importation of fish into localities where they were either already abundant or to which they were unsuited. But mistakes of this kind may be avoided if those interested in the subject will purchase the pamphlet on the "Indian Fish of proved utility as mosquito destroyers," by Captain Sewell and Mr. Chaudhri, which is published by the Superintendent of the Indian Museum at the nominal price of 8 annas. From a perusal of this pamphlet we learn that the four genera that are to be relied on are *Haplochilus*, *Ambassis*, *Trichogaster* and *Nuria*, and more specially to the various forms of the first mentioned, whilst discredit is thrown on *Anabas Scandens*, "the climbing perch" which apparently only feeds on mosquito larvæ when in captivity. I would like also to direct your attention to the virtues of the water snail, "*Linnaea stagnalis*," which according to McCabe is a most voracious devourer of mosquito eggs, and to the extremely interesting paper by Mr. Wilson on "Larvicides and the natural enemies of mosquitos in Southern India" which Mr. Wilson is reading before this conference.

Lastly I would mention the provision of a pure water-supply. We all of us know that when from any cause the health of the host is depressed the malarial parasites increase in number and that the reverse occurs when from any cause the health of the host improves. The improvement of the general health of the individual therefore, by enabling him to develop the resistant power which will enable him to throw off the disease, is an important feature of our anti-malarial campaign, and for this reason we regard the provision of a pure water-supply in rural areas as an anti-malarial measure of vital importance, and the Scientific Advisory Board believe that if with this be combined systematic jungle-clearing, water-tidiness, the preservation of mosquito-destroyers and the distribution of quinine, it may be possible to achieve remarkable results even in areas where the physical conditions render large drainage-schemes, etc., practically impossible. For this reason I have noted with great pleasure the formation at Jessore, on the 12th of December last, of a Coronation Anti-malarial Society which apparently intends to work in the villages of Bengal on lines very similar to those indicated above, and I am sure you will all unite with me in wishing this society every success and in congratulating Rai Jadunath Mazoomdar Bahadur upon its inception. I trust that it marks the beginning of that cooperation of the public, upon the necessity for which I have insisted so often, and without which we can never hope to attain real success in our campaign against malaria.

And now I wish to say a few words with reference to the subject of quinine which formed the subject of our second resolution at last year's conference. During the past twelve months quinine prophylaxis has been the subject of severe criticism by many observers who have pointed out that even when persons are taking large doses of that drug, more than 25 per cent. of them still show malarial parasites in their peripheral blood. It has been suggested in certain quarters that in India this is due to the fact that the Government quinine is inferior to that supplied by European firms, either as the result of defective manufacture or as the result of deterioration from storage in a hot climate. These statements which are absolutely without foundation in fact, it is my duty to refute. In 1910 our white quinine, both of Bengal and Madras manufacture, was subjected to independent analysis in Amsterdam and it was proved that in every respect it was of the same chemical composition and purity as the very best English quinine. If further confirmation is required to this statement, I refer you to Captain Lelean's criticism of quinine prophylaxis which appeared in the R. A. M. C. Journal for November 1911, where you will find that after submitting for analysis sealed samples of Government quinine taken from Delhi, Muttra and Agra station hospitals, the writer is bound to acknowledge that not only did the men get quinine, but they got quinine of excellent quality. The other suggestion was that our quinine had undergone certain molecular changes resulting in the production of inert quineretin. The Government Quinologist whom I consulted on this point, informs me that solid quinine sulphate is not changed in any way by any temperature short of that of boiling water and that

the most intense light only alters it superficially. It is not known to be affected by a damp atmosphere and it is only dehydrated in a dry one. He tells me too that Quineretin is the name given to an undefined brown product of the action of sunlight on an aqueous solution of quinine, and it is possible that the yellow coloration formed on the surface of solid quinine after prolonged exposure to light may be due to the formation of this substance. But the amount so formed even after the most drastic treatment is infinitesimal and can have no practical effect upon the therapeutic value of the Indian drug. I may note moreover that Watson in Malaya using quinine of English manufacture, has had similar experience and I would call your attention to a note by Captain Ryley in a recent number of the R. A. M. C. Journal in which he describes an experiment made in Hongkong with two Companies of the Middlesex Regiment. The men in one Company were given daily doses of 5 grains of quinine, whilst the second Company received none at all. The result of the experiment was that 47 per cent. of the men in the first Company showed parasites in their blood, and 49 per cent. in the second. That this failure was not due to any deterioration or staleness in the quinine used was proved by the fact that in therapeutic doses the same stock solution speedily removed the parasites from the blood of patients in hospital. If therefore, gentlemen, you have failures in quinine prophylaxis, it must be the method which is at fault and not the drug.

That the method itself is at fault is I think clearly shown by Thomson in an article in the July number of the Annals of Tropical Medicine and Parasitology. In his opinion the faults of the five grains daily method are three in number :—

(1) This amount is insufficient to prevent infection from mosquitos.

(2) It is an insufficient amount to render the blood uninhabitable by the malarial parasite, and hence it takes a long time to eradicate malaria from the system or it may even fail altogether especially if there are many crescents.

(3) This amount makes the blood less suitable for the parasites and hence tends to keep the disease latent in the system without curing it.

These three postulates seem to me to offer a very reasonable explanation of the failure of quinine prophylaxis and to render unnecessary the formulation of any theory as regards the development of a strain of quinine-immune parasites. It is however only fair to state that Professor Celli does not admit that quinine prophylaxis is a failure. On the contrary in his recent report which has been translated into English by Major Lalor, and which is before the meeting, he predicts a final triumph for this method far greater than that which in his opinion it has attained in Italy. On reading his essay however, you will see that he bases his arguments on a comparison between the effect of the prophylactic use of quinine and those obtained by what in Italy is termed "human reclamation," that is to say, the treatment in the inter-epidemic period of all chronic patients suspected to be "reservoirs" of malarial infection. The latter method is not adopted in India and I think most people will admit that it is doomed to failure, seeing that it is these chronic cases that are the most fertile producers of crescents which can only be destroyed by large doses of quinine taken regularly for several weeks. In view therefore of the objections to quinine prophylaxis on the part of the people in this country, I fear we must adhere to the terms of our last resolution and that so far as the free population is concerned, quinine prophylaxis in India, must be largely restricted to the destruction of the parasites in the blood of those who are suffering from malaria in either its acute or chronic form, especially during the fever season.

From the subject of quinine we naturally pass on to that of Black-Water Fever. As you are aware there are three hypotheses as to the etiology of the disease.

(1) That it is the result of quinine poisoning.

(2) That it is either a manifestation of an active malarial infection or the result of a condition brought about by a previous infection.

(3) That it is due to some undiscovered specific organism.

Notwithstanding the fact that the last mentioned theory is discredited by those who have studied the disease in India and in the Canal Zone, at Panama, we must not forget that it is not so very long ago that Kala Azar was regarded merely as a manifestation of intense malaria, and it is interesting therefore to note that Leishman in examining blood films from a case of Black-Water Fever which occurred in Uganda has found in them certain cell-inclusions which he suspects may possibly represent an invasion of the endothelial cells of the visceral blood vessels or lymph channels by parasites of the nature of Chlamydozoa. Low reports that he has found similar cell-inclusions in the blood of cases of fever from Borneo and Pellagra from Italy, and he suggests that, although time alone will show whether Black-Water Fever, Pellagra, and some of the undefined tropical fevers are due to parasites of the nature of Chlamydozoa, further researches into the etiology of diseases with filterable viruses such as Yellow Fever, Dengue, Pappataci fever, etc., in the light of Prowazek's discoveries, are very likely to be crowned with success. These three diseases seem to form one natural group and there is reason to believe that their pathogenic organisms may be closely allied. The authorities of the Yellow Fever Bureau, therefore, have decided to include in future in their Quarterly Bulletin both Dengue and Pappataci fever, and to publish later on investigations into these two diseases. Here in India investigations are particularly necessary to clear up many doubtful points, such for instance as to whether or no the "seven-days" fever of Rangoon and Calcutta is or is not Dengue; secondly as to whether or no the "three-days" fever of Chitral and Gilgit is or is not identical with Pappataci fever; and lastly whether or no Dengue, "seven-days" fever, and "three-days" fever are distinct diseases, or whether, as Megaw suggests, they are different forms of one and the same disease. Then too, there is the question of the insect carrier about which it seems to me we appear to be in a hopeless state of confusion. Dengue is said to be carried by *Culex fatigans* and Pappataci fever by *Phlebotomus pappatassi*. But many epidemics of "three-days" fever have occurred in stations where no *Phlebotomi* could be found even after the most careful search. On the other hand *Phlebotomi* have been regarded as the carriers in certain epidemics of "seven-day" fever, as in the Cavalry Lines at Secunderabad; and finally Lalor has given it as his opinion that the carrier of the "seven-days" fever in Rangoon is probably *Stegomyia fasciata*.

Time will not permit of my dealing with the important subject of the diseases of the "Leishmania" group. Neither do I wish to anticipate the discussions which will arise on the interesting papers that will be presented to you. There are two points however in connection with Colonel Donovan's valuable paper on Kala Azar upon which I wish to lay particular stress. The first is in connection with his view that one method of infection may be by the mouth, in support of which theory he instances the frequency of intestinal lesions in this disease. This view is in accord with the observations made some years ago by Bentley in Assam to the effect that if one person in a hut is attacked by Kala Azar it does not as a rule spread to the other inmates unless the first sufferer develops dysenteric symptoms. It seems to me therefore eminently desirable that, whilst continuing our laboratory experiments, further field investigations should be undertaken in Assam, where the conditions for the spread of this disease appear to be peculiarly favourable. The second is in connection with Colonel Donovan's successful attempt at infecting a dog with the disease. The *post mortem* examination showed extensive infection of the bone marrow whilst the liver and spleen were apparently healthy. This renders it necessary that we should reconsider our position as regards the insusceptibility of Indian dogs. So far as I know, in previous examinations only the spleen and liver were examined and not the bone marrow. If I am correct in this supposition it is obvious that a further series of observations will be necessary before we can say with confidence that the Indian dog is immune to "Leishmania Donovani."

Lastly there is the question of the Spirochaetoses. We have known for some time that small out-breaks of relapsing fever occur frequently in the jail of the Meerut district—they are not serious and there are reasons for believing that the disease, which is probably endemic in the villages of the Jumna Kadir, is frequently unrecognised and treated as malaria. This spring the death rate was noticed to

be rising in the Meerut district and in the first case it was presumed to be due to plague. The villagers however refused to recognise it as such chiefly on account of the comparatively low mortality, so certain medical officers were detailed to visit the villages and take blood films. These on examination showed numerous typical Spirochaetae and subsequent investigation has shown that some 70 villages in the Meerut district are infected with this disease. These villages will, we think, form an excellent starting point for the investigation, which it is proposed to institute next year, into the etiology of Relapsing Fever, especially with a view to settling the question of the "carrier" of the disease and the exact mode of transmission.

Several years ago Mackie working in Bombay demonstrated the fact that the carrier of Relapsing Fever is *Pediculus Vestimenti*. These observations have now been confirmed by Nicolle, who has gone a step further than Mackie and has investigated the exact mechanism of transmission. According to him, the Spirochaete, after ingestion by the louse, undergoes in its digestive tract a series of transformations finally becoming a "filterable" micro-organism, in which form it traverses the intestinal wall and lodges itself in the general body-cavity of the louse, where it again assumes a spirillar form. It is obvious therefore that the *Pediculus* cannot convey the infection by biting. In order that this may occur, it is necessary that the insect be crushed and that the spirilla it contains should come in contact with an abrasion of the skin. This distinctly novel method of transmission, which is not in accord with the views of Mackie and other observers, certainly deserves further investigation.

Then in the October number of the Indian Medical Gazette, you may have seen that Browse reports the discovery in Quetta of a Spirochaetal infection which differs in important details from either the classical Relapsing Fever of Vandyke Carter or the African Tick Fever. The disease is confined to the Regimental Followers' Quarters in which *Cimex* and *Pediculi* are very numerous. Considerable numbers of a Tick, said to be *Ornithodorus Tholozani*, and one specimen of *Argas Persicus*, were also found. Notwithstanding the observations of Mackie and Nicolle, Browse is inclined to put the first three insects out of count, and he suggests that this new disease is identical with one which is known in Persia as Miana and which is said to be conveyed by *Argas Persicus*.

I think I have said enough, gentlemen, to show that the pyrexias of uncertain origin offer a wide field for research, and in conclusion I cannot do better than quote a paragraph from the Presidential Address on the Fevers of India delivered by Crombie some 18 years ago at the first Indian Medical Congress held in India in December 1894. He said "We have allowed a Frenchman to find for us the amœba of our malarial fevers, and a German the comma bacillus of cholera which is surely our own disease. Shall we wait till some one comes to discover for us the secrets of the continued fevers which are our daily study, or shall we be up and doing it for ourselves?"

Gentlemen, let us be up and doing. The Central Research Institute at Kasauli, the Bacteriological Laboratory at Parel, the King Institute at Guindy, the Calcutta School of Tropical Medicine, and, let us hope, ere long the Pathological Institute in this city, will afford our younger brethren unrivalled opportunities for carrying out original investigations, and I can assure you that any well considered scheme for research work will receive the fullest sympathy and assistance both from the Scientific Advisory Board and from the Government of India.

A recent article in the Indian Medical Gazette has told us what the Indian Medical Service has done for India in the past. Let us now band ourselves together and show the world what the Indian Medical profession as a whole,—whether official or non-official, whether European or Indian,—is doing for this country in the present and what we hope to accomplish in the future.

I wish to ask you all to join with me in welcoming here this morning Sir Harold Stuart who, during his tenure of office as Home Secretary to the Government of India, did so much towards the foundation of the Indian Research Fund and who took so prominent a part in our first malarial meeting in Simla in October 1909.

Report of the Malaria Bureau.

Captain E. C. Hodgson then presented the report of his work as officer in charge of the Malaria Bureau, Central Research Institute, for the year 1911-12. The following is a summary :—

A complete set of all the known Indian anopheles having now been obtained, the work of the Central Malaria Bureau has consisted first in making as many duplicate sets of the type specimens as possible, to enable officers working at the Bureau to take out and thoroughly examine specimens without there being any danger of the type ones being injured or destroyed; secondly, in making up and sending to public institutions and colleges, both in India and abroad, complete sets of Indian anopheles or as nearly complete sets as it is possible to obtain within a reasonable time. A large number of varieties were collected for the malaria and bacteriology classes. A point was made this year of collecting and identifying as many varieties of fish as were known larvæ feeders throughout their lives. Drawings of typical malaria parasites having been made and painted under a camera lucida, these were photographed and coloured with Japanese water colours.

The President added that exchanges of collections of indigenous mosquitos had been effected with the Malaria Commission, Pirogott Society, Moscow.

Malaria in the Madras Presidency.

Captain J. H. Horne introduced his paper on "Malaria in the Madras Presidency," of which the following is a summary :—

A preliminary enquiry into the vital statistics of the Madras Presidency for the past 10 years was commenced on August 16th, 1912. The plan followed was—

(*a*) the graphing of total mortality figures; and

(*b*) the critical examination of seasonal swings and epidemic rises.

The investigation being still far from complete, five districts only have been chosen for the purposes of this paper, each representative of one of the five natural divisions of the Presidency. Of these only one shows evidence of epidemic malaria, *viz.*, Cuddapah, an upland district of the Deccan, barren, dry, and possessing a rainfall which is usually scanty but when heavy is liable to cause floods. There were two epidemics in this district, in 1909-10, and 1910-11. Both were localized; both occurred during the cold weather, October—February; both began and ended, in all the *taluks* involved, at the same time. The highest epidemic figure for a *taluk* was 5; in certain villages it was as much as 15. The epidemics were associated with increased rainfall, but not with drought in the previous year. They were followed by a marked reduction of the birth ratein the following year. Of the other districts, one, Chingleput, is known to contain centres of endemic malaria. Here the birth rate is high and the infantile mortality heavy. The mortality curves tend to be highest at the end and beginning of the year. The districts, South Canara and Vizagapatam, the latter long known to be malarious, show marked rises in the mortality curves during the later and first months of the year, in some cases reaching an epidemic figure of 3. These are very suggestive of malaria, but fuller examination of Jail and hospital returns will be necessary. Tinnevelly, a Southern district, flat, sandy, and hot with a scanty rainfall, also shows high cold weather rises, but these are entirely due to cholera.

Malaria in Bengal.

Major Fry then introduced his report on Malaria in Bengal. The report was a full one and dealt with various parts of this large province and showed how conditions varied in different localities.

The main points brought out were that malaria in the Ganges delta is endemic, but not universal, and that it is confined to those parts which suffered from a severe epidemic, in the middle of the 19th century. Parts which escaped the epidemic then are now free of endemic malaria, though physical conditions, density of human population and number, and variety of anophelines show no marked variation.

A malarial survey of two adjacent *thanas* in the centre of the endemic area, comprising a spleen census of the children in every village, shews that the level of malaria is very uniform and that villages on dead rivers and *bheels* do not differ so markedly as might be expected from their neighbours placed in more open and drier situations.

The absence of mosquito larvæ in permanent waters and the importance of fish as destroyers of larvæ is dealt with.

The report states that there is no evidence in support of the view that jungle produces malaria. It is pointed out that the so-called jungle is really a plantation of fruit trees and bamboo, and that the amount of jungle is a measure of the age of the village; therefore to attribute hyperendemic malaria to the presence of jungle is fallacious, the real explanation being that very jungly villages are old villages and being old were attacked during old epidemics and remained infected. The less jungly villages are new colonisations occupied by immigrants after the epidemic years.

Kala-Azar is found widely distributed but does not account, in the opinion of the author, for more than 5 per cent. of the splenomegaly.

The anophelines of Bengal include three Myzomyias—*Listoni*, *Culicifacies* and *Albirostris*. *Myzorhynchus Nigerrimus* and *Barbirostris* are common, but the only species which is really abundant is *Nyssorhynchus Fuliginosus*. Dissections of this mosquito shewed that the salivary infection rate was less than 1 per 1,000.

Statistical results do not show any particular factors influencing malaria, except in the dry areas of Chota Nagpur and Orissa where high prices apparently produce a high fever death-rate.

In the summary and conclusions, the report emphasises the nature of the delta and the vast area affected and the difficulties of comprehensive drainage schemes which would be undertaken in opposition to the natural phenomena of delta formation. Smaller drainage schemes are very expensive and the benefits of these, if any, would be very local. The conclusion is therefore reached that the best preventive measures that could be adopted are village sanitation and adequate treatment of the sick, so as to reduce the gamete carriers which are the reservoirs of the disease and keep it going from year to year. Village sanitation in the present state of public opinion is non-existent; the importance of education is therefore most strongly insisted on.

The non-deltaic parts of the province are briefly dealt with. In the Darjeeling Terai, hyperendemic malaria exists with a very small anopheline population.

In Chota Nagpur, hyperendemic malaria exists only in the submontane regions; the open plains where rice is cultivated are malaria free.

In Orissa the villages bordering the Chilka Lake were highly malarious and many varieties of anophelines were found breeding in the brackish water. Away from the lake the villages are free from malaria.

Malarial Investigation in the Central Provinces.

Major T. G. N. Stokes next introduced his paper on Malarial investigation in the Central Provinces: the following is a summary:—

The malarial investigation in the Central Provinces has been in progress during the winters of 1910-11 and 1911-12, and is now completed in 10 of the 22 districts. The completion of the work in the remaining districts is to be hastened by investigations throughout the year. Endemic malaria is widely prevalent more particularly along the Satpura hills. The causes assigned are the presence of jungle, etc., in the vicinity of villages, the presence of harmful anophelines, low economic condition of the people and social conditions. Endemic malaria increases the death-rate by about 10 per mille per annum. Villages of the Vindhyan range of hills are not hyperendemic—harmful anophelines are few. Severe epidemic malaria has not occurred in the province. Results of investigations tend to show that scarcity and high sub-soil water are not essential to epidemic outbreaks.

Brief particulars are given of two cases of Black-water fever among Europeans, one however being regarded rather as a case of malignant malaria.

Malarial Survey of Imperial Delhi.

Captain Hodgson next spoke on some points of interest in the malarial survey of the New Imperial Delhi. Two or three facts of interest he said have come to light in the course of the investigation. The district is divided by a range of hills and this gives rise to two distinct areas. The river runs from north to south. The area bordering the river is exceedingly malarious. The area which is to contain the new capital shows a low spleen rate and is the most healthy of the whole district.

Anopheles show striking differences in their relative proportions; 7,400 were examined. In the Darbar area *Culicifacies* outnumbered *Rossi*. In the new area *Rossi* outnumbered *Culicifacies*. In the city of Delhi itself the numbers also vary, *Rossi* easily lead, *Stephensi* come next, and *Culicifacies* last of all. Captain Hodgson, like Major Fry, has not found a single infected *Fuliginosus*. Five per cent. of *Culicifacies* and four per cent. of *Stephensi* were infected.

As regards sub-soil water, in the Darbar area, it was only 7 feet and in some places only 3 feet from the surface. In the city, on the other hand, it was about 16 feet; at the new site the depth drops to 30 feet. There seems to be a very close relation between the spleen rate, depth of sub-soil water and the percentage of dangerous anopheles present.

The Bela is a stretch of land which is largely marshy. The anopheline larvae found on this stretch of land were in extraordinary numbers. The Bela extends along the eastern wall of the city and from it great numbers of anopheles come into the city. When the situation of No. I Ward to the Bela is taken into account, it is not difficult to understand why it shows itself to be specially infected. Out of 25 individuals attending the malaria class, 8 developed fever in spite of the fact that they were all taking prophylactic quinine except one who took none and he had a malignant infection. As regards the troops, they are quartered on the eastern side of the city facing the Bela. The incidence of malaria amongst them corresponds closely to that found in the city.

The malaria rate showed a very definite rise in April and May, though these are not rainy months. This may indicate that zygotes mature only in a definite temperature and that special attention in investigation should be given to humidity and temperature.

Malaria in the Jeypore Agency Estate.

Major E. L. Perry then spoke on the endemic Malaria of the Jeypore Agency Estate, Madras Presidency, and illustrated his address with charts. The following is a synopsis of his notes on the subject :—

There is very little malaria in the greater portion of Vizagapatam Town, the spleen rate of children being under 2 per cent. Close to the harbour and near the Coromandel Company's office, however, a high spleen rate is found, and on the south side of the harbour the spleen rate of children in the villages reaches as high as 70 per cent. This condition of affairs may have arisen from the silting up of the harbour, interfering with the natural drainage of the surrounding land. So marked a variation in the amount of malaria within quite a limited area, if studied, should throw light on the relation of malaria to the numbers and conditions of anopheles necessary to carry it. There are abundant breeding places in and about Waltair. As two instances, of places on the East Coast of Madras, which have become highly malarious, though originally healthy, Ennur and Ganjam were cited, it would be advisable to determine whether malaria and the conditions causing it are likely to spread further into Vizagapatam. A large colony of fisher people were some years ago removed from Vizagapatam Town to the south side of the harbour, but they suffered so terribly from malaria there that the municipality had to allow them to return to the town.

A map was exhibited showing the position of the country investigated. It lies entirely in the Eastern Ghats inland from Vizagapatam and borders both on the Central Provinces and Orissa. As shown it may be roughly divided into three plateaus. The upper, or 3,000 feet, plateau comprises the Pottengh, Koraput and Padwa *taluks*; the Jeypore and Naurungpore *taluks* comprise the 2,000 feet plateau, and the Malkangiri *taluk* forms yet a lower plateau, sloping from six or seven hundred feet above sea level down to the Godavery. The upper or 3,000 feet plateau differs from the two lower plateaus in being covered with low hills, from the sides and bases of which appear innumerable perennial streams. It is these perennial streams which constitute one of the specially malarious features of the 3,000 feet plateau. Throughout all three plateaus the preponderating geological formation is laterite. The hills are inhabited by wild and primitive tribes of whose origin but little is known. Many of them speak dialects of the Munda family of languages. From the writings of Risley, Thurston and Grierson it would appear that the Munda language is entirely distinct from Dravidian. It therefore appears possible that these tribes may be even older than the Dravidians themselves. There is no reason to suppose they ever lived under less primitive conditions than they do at present. They certainly must have occupied jungles similar to those they do to-day for many thousands of years. In the course of these thousands of years it is probable that all but the most virulent strains of malarial parasites have been eliminated from the blood of these aborigines.

The charts prepared to show the rainfall in different parts of the country, demonstrate that the rainfall does not determine the malariousness of any place. This is also obvious when the fact is considered that places within a mile or two of one another can have such widely differing spleen rates as 25 per cent. and 80 per cent.

A map of the country around Koraput which was shown, brought out the relationship of the perennial streams of the upper plateau to the amount of malaria. Koomba which has a comparatively low parasite rate in the spring, has fewer perennial streams adjacent to it than Chindrigaon and Koraput villages which have a higher parasite rate in the spring. The parasite rates become equal as the rains are becoming established. The spleen rates are identical.

On the upper plateau, denuding the country of jungle to the verge of desolation does not appear to reduce the spleen rate much more than from 95 per cent to 85 per cent. On the lowest plateau which is flat and not broken up into innumerable hills, nor intersected by a multiplicity of streams, clearing the jungle and substituting rice cultivation may in places bring the spleen rate down to as low as 25 per cent., a figure recorded in a village near Naurungpore.

On the lowest plateau the proximity of large deeply cutting rivers, such as the Kolar and Indraviti, appears to favour a great lowering of the spleen rate. This is probably due to the fact that the tributaries of such rivers flow largely below ground.

A map exhibited showed the remarkable variations in the spleen rate in villages in the neighbourhood of Jeypore. In the neighbourhood of Naurungpore further from the hills, still lower spleen rates were recorded.

Charts exhibited showed the spleen rate amongst the different castes and tribes and exhibited the vastly different manner in which the aboriginal and immigrant races react to malaria. Stress was laid on the importance of observing the spleen rate of all ages if the manner in which a community reacts to malaria is to be understood.

Another chart showed the percentage prevalence of anopheles on the upper plateau throughout the twelve months that they were kept under observation. Anopheles on this plateau are prevalent throughout the whole year. It was shown how the stream breeding species abound in the dry season and how they are suppressed with the exception of *Listoni* and *Jeyporiensis* during the rains. *Culicifacies* comes and goes with the rains.

The great prevalence of quartan in this country and the fact that malignant parasites are very rare except when *Culicifacies* is present, is strong presumptive

evidence that the stream breeding species *Listoni*, *Theobaldi*, *Jeyporiensis* and *Maculipalpis* are largely concerned with the carriage of quartan, and that *Culicifacies* is chiefly concerned with the carriage of malignant parasites. The evidence acquired in the Punjab strongly supports this view, for where in the Punjab quartan parasites are excessively rare, such stream breeding species are also excessively rare or absent. The low degree of prevalence of malignant parasites amongst the aborigines of the Jeypore country may partly be due to increased resistance to that parasite.

Major Perry instanced the Jeypore Estate as an example of a country where a great anti-malarial operation, namely clearance of jungle, should prove of great benefit provided it was undertaken with discrimination.

Dr. Bentley introduced his paper on "a new conception regarding malaria."

A new conception regarding malaria.

After emphasizing the distinction between mere malarial infection and malarial disease, the different results to be observed in infections among non-immunes and those partially tolerant respectively, and the fact that infestation by malarial parasites is not to be considered as invariably an abnormal condition, but often as natural among primitive races as flea infestation is to a dog, the paper proceeded to outline a new hypothesis regarding epidemic infective diseases in general, and showed its special applicability to the case of malaria. After premising that man, in common with other organisms, always tends to become adjusted to his environment, which often includes a host of parasites of all kinds, it is suggested that the occurrence of epidemic diseases is always the result of a serious change in environment, by which conditions formerly favourable to life have become unfavourable. Such changes may be either the introduction of an unfamiliar parasite, the effect of unusual seasons, or the result of the vast upheavals produced among primitive parasite-laden races by advancing civilization. Epidemiology therefore involves the study of populations in relation to their environment, of which their special parasites form only a part; and the proper study of malarial disease necessitates an examination of all the factors influencing the life of the affected community, besides those specially related to the condition of infection. The prevention of disease and the final elimination of parasite infestations, especially that of malaria, can often be achieved more quickly and surely by indirect methods than by direct attacks upon the disease. Improvement in agriculture is probably the most useful measure that can be used against malaria among rural populations.

Dr. C. A. Bentley then introduced another paper on some problems presented by malaria in Bengal. The following is a summary:—

Malaria Problems in Bengal.

In certain areas in Bengal, depopulation has been going on for many years. These areas invariably show a high incidence of malarial infection, and a heavy death-rate, and it has usually been supposed that the depopulation is due to an increase of malaria. Investigation shows, however, that a decay of prosperity following upon the impoverishment of the soil, in areas no longer receive a supply of rich silt from the overflow of the subsidiary channels of the Ganges, which intersect the deltaic portion of Bengal, is largely responsible for depopulation. The process of soil exhaustion has also been hastened by the extensive planting of jute. As a result of these changes many communities have been reduced from a former state of prosperity to one of poverty, much land has gone out of cultivation and a co-incident increase of malarial infection has taken place.

The remedy for this condition is not to be sought in special drainage schemes, extensive jungle cutting or other more direct attacks upon malaria, but by an improvement in the methods of agriculture which may eventually restore the prosperity of the affected areas.

THE DISCUSSION.

Major Graham said that his experience corresponded with that of Major Fry, with regard to *Fuliginosus*, that is to say, that it is difficult to incriminate this

mosquito as an important carrier. He had been incriminating fewer and fewer for the past three years, and this year he had not been able to incriminate any.

Major Lalor said that the discrepancies between Major Fry's observations and his own, with regard to the part played by *Nyssorhynchus Fuliginosus* as a malarial carrier in nature, induced him to make a brief disclosure of a subject which he had intended to reserve for future communication; he therefore announced the following provisional thesis.

Of anopheles which in a given locality—with a *stationary* population—are potential malarial carriers, one alone may during a given period be found to act as a malarial carrier while its sporozoit rate will vary to the point of ultimate disappearance. When such disappearance takes place the malarial carrier concerned will be found replaced in that capacity by one of the remaining potential carriers of the locality, which in its turn may be replaced by yet another.

Captain Hodgson said that the Bela at Delhi, which before its clearance of jungle, gave numerous breeding places of *Barbirostris*, presented a very different state of things now that the clearance had been effected. Referring to wells he described a method that had been adopted of dragging a net over the top of a well in order to trap larvae. He said that *Stephensi* was a larva which rapidly sank to the bottom of a well and stayed there a very long time, a fact which may materially affect the catch. The dropping of the net into a well with a splash would cause the larvæ to drop as they were very nervous and the slightest disturbance would cause them to sink.

Dr. Rutherford said that in West Africa jungle clearing was considered of paramount importance. It was insisted on in and around all the villages. The decrease or absence of malaria was generally attributed to this measure.

Major Graham, speaking of Major Perry's remarks on aboriginal tribes in relation to malaria, said that Major Robertson and he had made an enquiry in 1909 into the malarial conditions prevailing amongst the aborigines (Tharus and Bukhsas) of the Naini Tal Terai who were currently believed to be immune to malaria, a fact mentioned in the Gazetteer. They were found to be the reverse of immune and their children showed a heavy malarial mortality. Living alongside the aborigines were plains immigrants, and it was found that the aborigines showed a very definite relative immunity, in other words, a racial immunity of a much higher degree than that of the immigrants.

Dr. Bentley pointed out that in Bengal the difficulty was that they had not to clear away primary but secondary jungle, that is, jungle which had grown up upon old or exhausted village sites. It was not productive but unproductive and exhausted soil which they had to clear, and which occurred in country going out of cultivation.

Major Stokes said that in the Central Provinces experiments are being made as to the value of jungle clearing and "water-tidiness" in some selected villages situated in hyperendemic areas. The villages have been taken in pairs, the two members of a pair possessing similar endemic features. One village is used as a control, measures being concentrated on the other. Quinine is of course withheld so as to try and demonstrate the real value of anti-mosquito work in them. The experiment was probably a costly one, but should give valuable results. The people had not raised any difficulties whatever.

Major Fry said that money had been granted by the Government of India for experimental work in regard to jungle clearing. He also described the real jungle growth of Bengal. A thick jungle was a sign of a large or a very old village that had always been a hot-bed of malaria.

Major Perry said that the only place he had found in which jungle clearing had any beneficial effect was upon the lower plateau of Jeypore. He thought it was necessary to take into account the geological formation of a country in considering its relation to jungle clearing. Referring to Major Lalor's remarks concerning the burning of jungle, he said that the jungle on the upper Jeypore plateau was burnt every year, but that did not appear to have any good results.

Dr. Bentley said.—When Major Perry spoke of the influence of economic conditions upon malaria, he referred to a continuous state of affairs, whereas, the economic conditions which he considered as of the greatest importance were those which were subject to sudden alterations.

Anopheline distribution in the United Provinces.

Major J. D. Graham, Special Malarial Officer, United Provinces, than spoke on mosquitos in his province and illustrated his remarks with charts. The following is a summary of the paper.

The accumulated observations of the special officer for malaria since November 1908 have provided data for a brief statement of the provincial anopheline distribution. The province from its physiographical and economical aspects would lead one to expect gradations into the fauna of the Punjab on the north-west, Bihar on the south-east and the Central Provinces on the south. Dividing it into a Himalayan area of hill and terai, a sub-montane area, a doab or riverain, and a central dry area, we find that the upper Himalayan fauna is sharply demarcated from that of the doab, and merges by gradations into that of the terai and sub-montane. Observations have been made in the upper Himalayan region at Almora, Ranikhet, Naini, Bhowali, Dharmoti and Kalighat; in the terai of Dehra Dun, and Naini Tal as far as Nepal; in the sub-montane region at Saharanpur, Nagina, Moradabad, Bareilly, Pilibhit, Gonda, Basti, Gorakhpur; in the doab at Kairana, Meerut, Muttra, Kosi, Etawah, Fatehgarh, Cawnpore, Allahabad, Fyzabad, Ghazipur, Ballia; and in the central region at Rai Bareli, Lucknow and Hamirpur. And briefly the findings have been that *Culicifacies* and *Fuliginosus* are universal: *Rossi* is not found in the hills, but appears in the terai and is in abundance everywhere else: the mountains give *Willmori* and *Lindesayi* but neither *Stephensi*, *Nigerrimus*, *Barbirostris*, *Pulcherrima* nor *Maculatus*: *Stephensi* and *Nigerrimus* appear in the terai and continue through the other areas, while *Barbirostris* and *Pulcherrima* appear in the sub-montane area, persist in the doab, but are not found in the central areas or Bundelkhand: *Maculipalpis* is not found in the mountains, appears in the terai and diminishes towards the doab: *P. Simlensis* appears in the Himalayan area: *Maculatus* appears in the terai: *Pulcherrima* is comparatively rare. Since the 1908 epidemic a series of mild malarial years may have caused a quantitative and qualitative alteration in the species which it is difficult to estimate, but a very similar sequence of appearance in widely separated areas would indicate considerable regularity in the laws governing their bionomics which only extended observation over a series of successive years in fixed localities is likely to establish.

Rai Kailas Chandra Bose Bahadur next introduced his paper on the breeding of mosquitos, of which the following is a summary:—

The breeding of mosquitos.

Mosquitos breed better in old than in new earthen vessels. They resent the earthy smell of new pots. They dread to approach glass bowls when placed over a mirror and kept in a well-lighted room. Two to three days is the average period for the hatching of eggs. Mosquitos generally select the small hours of the morning for laying their eggs. The larvæ thrive well when some nutriment is put into the vessel of water, and they pass into their pupal stage on the fourth day. Under ordinary circumstances they take five days to reach their pupal state. Saturated solution of sugar is a bad medium for the breeding of mosquitos. Green Anhatoda vasica is no bar to the growth and development of mosquito larvæ. Kerosine is simply unique in its larvicidal property. Pupae require no food and the pupal stage ranges from two to three days. The transition from the pupal to the mosquito stage is uneventful. Mosquitos resent strong smells and at times they show signs of possessing the sense of hearing.

Malaria and mosquitos in the Kashmir Valley.

Relation between the seasonal birth and death curves.

A paper by Colonel J. R. Adie, I.M.S., and Mrs. Adie, entitled "Note of an enquiry into malaria and mosquitos in the Kashmir Valley" was then read, followed by a paper by Major J. C. Robertson, I.M.S., entitled "A short note on the relation between the seasonal birth and death curves."

SECOND DAY.—NOVEMBER 19.

The delegates reassembled at the Council Chamber, Fort St. George, Madras.

Quinine and its Action.

The first paper presented was on the hæmolytic action of quinine and its salts with suggestions regarding the etiology and treatment of black-water fever by Major A. C. MacGilchrist, M.A., M. D. The following is a summary of the paper:—

Classification of quinine salts according to their hæmolytic power in vitro.

I. Strongly hæmolytic (acid salts).	Q. bi-hydrochloride. Q. bi-sulphate. Q. bi-hydrobromide. Q. urea bi-hydrochloride. "Indian hypodermic injection" (see Squire's Companion to B.P.)
II. Slightly hæmolytic	Q. quinate, Q. benjoate, Q. salicylate. Q. sulphate. Q. hydrochloride. Q. hydrochloride + antipyrine. Bacelli's intravenous injection. (Q. hydrochloride + sodium chloride). Q. hydrobromide, Q. formate (basic), Q. lactate. Q. valerianate.
III. Very slightly hæmolytic ...	Q. cacodylate. Q. carbonate. Q. acetate.
IV. Non-hæmolytic, yet do not delay antolysis, *i. e.*, inactive.	Q. arsenite. Q. phosphate.
V. Non-hæmolytic and delay antolysis.	Q. arsenate. Q. alkaloid or base.

Quinine hæmolysis in vitro.—The acid salts of quinine are powerful hæmolytic agents; the neutral salts are slightly hæmolytic; the alkaloid quinine itself is not merely non-hæmolytic, it delays autolysis.

Quinine hæmolysis in vivo.—Under *ordinary* conditions very large doses of an acid mixture of quinine can be given to rabbits without any hæmolytic effects becoming manifest. The hæmolytic tendencies of the acid quinine mixture become apparent however in two ways. Firstly, if the blood of a rabbit be kept in contact with this quinine mixture for three or four hours, even in a vein, hæmolysis takes place; secondly, blood taken from a rabbit within three or four hours after injection invariably hæmolyses sooner than blood drawn before injection. This latter effect was most evident in the case of young rabbits.

The chief factors which under normal conditions preclude hæmolysis by an acid mixture of quinine *in vivo* are—

(1) Greater concentration of the blood as compared with the 5 per cent. suspension used in experiments in vitro, (2) the presence of the serum, and, above all, (3) the neutralising effect of the blood plasma and the defensive action of the organism, exercised particularly through the liver, whenever there is danger from the presence of foreign acids and diminished alkalinity of the blood. In the presence of an acid dyscrasia and disordered liver, the results might possibly be very different.

Suggestions regarding black-water fever.—That some third factor is necessary besides malaria and quinine in the causation of black-water fever is generally acknowledged: may it not be an "acid dyscrasia"? Christophers and Bentley conclude that the third factor is *a specific hæmolysin* without being able to exclude the possibility of *a chemico-toxic body* being at work. There is a mass of experimental and clinical evidence which supports the

hypothesis of a diminished alkalinity of the blood in black-water fever, and the most successful methods of treatment in this condition are those that provide for the introduction of large amounts of alkali "into the blood" of the patient. The most striking symptoms of black-water fever are exactly those of "acidosis" or "acid poisoning." It is stated that potassium salts are taken regularly by the natives in the Sudan as a prophylactic against black-water fever. The hypothesis of an "acid dyscrasia" affords a readier explanation of the incidence and geographical distribution of black-water fever than does any other theory yet put forward. Granted a condition of diminished alkalinity of the blood, combined with malaria and quinine administration, it is evident that a vicious circle would be set up. The blood and urine of patients suffering from black-water fever require examination with a view to determine whether or not acidosis is present.

Uses of Quinine.

Major A. C. MacGilchrist also contributed a paper regarding the pharmacological action and uses of quinine.

The following is a summary:—

Of the annual number of admissions to hospital for malaria, two-thirds are relapses and only one-third are fresh infections. This shows that the present treatment of malaria is insufficient. If relapses could be eliminated by efficient treatment, more than two-thirds of the present incapacity due to malaria would disappear as those individuals that are liable to relapses by "carrying" infection, are responsible for the majority of the cases of fresh infection.

For efficient *treatment*, still larger doses of quinine are required. Larger doses than those usually given at present can be given with safety and benefit. Large doses of quinine taken with or soon after meals, at intervals of eight hours, keep the concentration of quinine in the blood at a high point throughout the twenty-four hours. No objections, either clinical or theoretical, to giving quinine during the fever period, exist, if the fever be due to malaria.

The after-treatment or disinfection of a malaria patient.—Are large doses daily better than large doses on two or three consecutive days at intervals of a week or so? This point can be settled only by actual clinical tests.

Prophylaxis.—Fifteen grains of quinine on two consecutive days each week are, for all practical purposes, an absolute preventive of malaria fever during the period such prophylactic treatment is carried out. This prophylactic treatment, however, does not disinfect the individual; it merely keeps the malarial parasites in subjection. After this quinine prophylactic treatment is stopped, relapses may occur.

Quinine prophylaxis does not increase the tendency to or favour the occurrence of relapses after such quinine prophylaxis has been stopped.

Action of quinine on blood vessels.—There is very little agreement amongst pharmacologists regarding the action of quinine on blood vessels. In poisoning by quinine, respiration invariably fails before the heart stops beating. By artificial respiration an animal can be kept alive for hours after natural respiration has stopped. In cases of quinine poisoning there is hope of recovery until the heart stops and refuses on mechanical stimulation (rhythmic pressure) to resume beating.

Action of quinine on the pregnant uterus.

Four conditions of the uterus are to be considered—

Non-pregnant uterus—

1. Non-menstruating (inactive).
2. Menstruating.

Pregnant uterus—

1. Quiescent.

2. Active, *i.e.*, abortion or labour (normal or premature) threatened or in process.

Two kinds of uterine muscle contraction have to be considered—

Expulsive.

Non-expulsive.

Experimental evidence and clinical experience agree that quinine, although it will greatly increase the expulsive contractions of the already active pregnant uterus, cannot induce or originate expulsive contractions in the quiescent pregnant uterus.

Quinine as a local anæsthetic.

The action of quinine as a local anæsthetic practically amounts to a *chemical resection of the nerves.*

A plea for a more extended use of quinine base.

The advantages of a pure precipitated amorphous quinine base are—

(1) Sparing solubility.

(2) Comparative tastelessness.

(3) Absorption as quick as with a salt.

(4) Bulk and weight small.

(5) Non-hæmolytic action.

(6) Cheapness.

Quinine base can be administered intravenously in two ways—

(*a*) As a 1 in 135 solution in 33 per cent. alcohol in saline.

(*b*) As a 1 in 2,000 or 5,000 solution in saline.

Intravenous injections of quinine salts.—A solution so concentrated as 1 in 150 is not recommended : the bulk of injection should be two or three pints.

Subcutaneous infusions of quinine salt.—Dr. W. M. James (Panama) recommends subcutaneous infusions in a dilution of 1 in 150. He gives large doses, *e.g.*, 30 grains in 10 ounces of saline in pernicious cases of malaria and reports excellent results, but Major MacGilchrist from his experiments on animals fears there must be extensive tissue destruction.

The Discussion.

Dr. C. A. Bentley complimented Major MacGilchrist on the excellent work he had done, but said that he did not agree with his conclusion on black-water fever, and took exception to his theoretical statements on the ground that the effects produced in vitro cannot be produced in vivo. Even large doses of hæmolytic salts and hæmolytic serum will not produce hæmolysis in vivo. The effect of injection of hemotoxins and hæmolytic sera is first to produce enormous phagocytosis, and enormous engorgement of the spleen almost immediately after. The phagocytosis precedes hæmolysis by a long period. Major MacGilchrist had also entirely ignored hæmolysins, although the existence of these bodies was well known and could be easily demonstrated. In cases of severe malarial anæmia Major Christophers and he (Dr. Bentley) had demonstrated the presence of antihæmolysin. This was probably as near as they could get to giving definite proof of the action of such bodies as hæmolysins *in vivo.* As regards the use of quinine and black-water fever, those who have worked in districts showing black-water fever know how this disease has been almost eradicated by the proper use of quinine. Dr. Bentley thought there was a great danger in raising any idea of the toxicity of quinine and questioned Major MacGilchrist's statement that the symptoms of black-water fever were essentially those of acidosis. An acute case of black-water fever resembled very closely a severe case of hæmorrhage as far as the symptoms of collapse and air hunger are concerned.

Major Perry wished to ask Major MacGilchrist if black-water fever be due to acidosis, how it was that such symptoms did not occur in other circumstances in which acidosis occurred. He asked how was it that black-water fever was not known in the Punjab, and yet in this province severe malaria was well known. He advised that the ethnographical conditions of a country should be considered even more than the geographical conditions in studying the distribution of black-water fever. The native of a country did not get black-water fever, and Major Perry considered that it was not a question of what particular country a European went to, but of what people he lived amongst. Major Perry considered that the presence of black-water fever was associated with the virulence of the malaria parasite and repetition of malarial attacks.

Dr. Korke asked Major MacGilchrist the following questions.

Is air hunger a pathognomonic sign of black-water fever? His experience in the school of tropical medicine had been different. Could not the air hunger be explained by the acuteness of the dyspnœa consequent on an acute hæmolysis? He did not see why it should be attributed to acidosis. He further asked whether observations on the stomach contents had been made, so as to determine the amount of alkali present, as his experience went to prove that the more acidosis there be the greater the alkalinity of the stomach contents.

Captain Berkeley Hill desired to know the experiences of other delegates on the question of the non-depressing action of quinine in doses not exceeding 20 grains.

Dr. Rutherford agreed with Dr. Bentley that great harm had been done in countries where black-water fever existed by the statement of Dr. Koch regarding the toxicity of quinine. The expression of such an opinion was exceedingly dangerous. As regards air hunger, it resembled that seen in violent hæmorrhage. The treatment of black-water fever required the injection of large quantities of fluid to make up for the loss and he had not found any advantage from the addition of alkali to ordinary saline. Death from black-water fever was like that which takes place during parturition.

Major Lalor said that he thought it would be admitted that some observed peculiarities in the geographical distribution of black-water fever have not yet been satisfactorily accounted for. With this reservation, the distinguished researches of Major Christophers and Dr. Bentley with regard to black-water fever went far to substantiate the view that it was due to an auto-hæmolysis sequent upon severe malaria. These researches tended to minimise the part which quinine has hitherto been supposed to play as a factor in the causation of black-water fever and in this respect they were supported by the conclusions of Major MacGilchrist—as formulated in the two valuable papers contributed by him. They were further supported by the opinion of Professor Celli in his essay upon Malaria in Italy during 1910, to his translation of which he invited attention. It appeared then to demonstration that the regular use not only of 'Prophylactic,' but also of 'Phylactic,' quinine, was devoid of all harmful results to the individual consumer. As to the question of its utility, Major Lalor said it was some considerable time before the best methods of quinine administration in the treatment of malarial fever were thoroughly understood, but it was now abundantly clear that to get the best result from quinine in the treatment of the sick, the drug has to be employed in suitable doses, by suitable methods, with suitable preparations, and at suitable times of administration. Common sense required us to believe that these four factors were of no less importance in the preventive use of quinine than in its use for curative purposes. He emphasised the distinction between the 'Prophylactic' and 'Phylactic' uses of quinine, so as to make it one not merely of separate nomenclature, but also and particularly one of separate method. He therefore would consider first the most suitable method of 'Prophylactic' administration. Professor Celli advocates the employment for this purpose of quinine in a divided adult dose of 6 to 8 grains daily, half to be taken in the morning and half in the evening. This method had an obvious scientific basis, for it insured that a certain small amount of quinine would always circulate in the blood; and this

amount—*plus* the power of resistance in a healthy individual was probably sufficient for his complete protection. An alternative method commonly employed was that of admininstering quinine twice weekly on each of two successive days in single doses of 10 to 15 grains. If one such dose be taken on Saturday morning and the second on Sunday morning, it was reasonable to suppose that the blood would be free from quinine from the following Tuesday morning to the next Saturday morning inclusive—a period of four days—during which severe infection might quite conceivably establish itself, especially in view of the fact that the plasmodium in the human body tended to propagate its species in geometrical progression.

He then turned to the consideration of the best method of administering 'Phylactic' quinine, and this involved reference to a suggestion which he said he would deal with at greater length in a subsequent communication. Briefly it amounted to this:—that, in obedience to a law of biological conservation the plasmodium when subject to adverse intra-corporeal influence, such as the presence of quinine in the circulating blood, tended to change from a form biologically active but vulnerable to specific remedy into one of biological inertia, in which its balance of vital energy assumed a potential phase more or less invulnerable to quinine. This form was of course the gametocyte, and the transformation which resulted in its appearance might, in a malarial subject who took his quinine in 'Phylactic' doses daily, give slow rise cumulatively to quite a number of gametocytes in his blood and internal organs, especially the spleen. It was likely that as soon as quinine was no longer present, those (probably only the quinine resistent) forms were capable of reverting to their original state of biological energy, by a process known as Parthenogenesis, the actual occurrence of which was well authenticated. It might be assumed that all starting from the same phase and pursuing similar periodicity would eventuate in so large a number of coincident merozoites, as to give rise to a febrile relapse.

The suggestion pursued to its logical limits presented further highly interesting considerations, but he remarked he would not then deal with these. It accounted in a rational manner, for the relapses observed to follow the consumption of quinine by chronic malarial subjects, and partially accounted for the fact that individuals who had been exempt from fever while in malarial localities, got fever for the first time shortly after their return to a healthy place. In such cases one might conclude that regular quinine consumption—whether 'Prophylactic' or 'Phylactic'—had been dropped at once after return instead of having been continued for a fortnight or more.

The best method of 'Phylactic' administration of quinine had yet to be decided.

Captain Hodgson remarked that Major MacGilchrist had said that 15 grains given twice weekly was stated to be a prophylactic. This was not his experience. Had Major MacGilchrist sufficient controls? In certain mild years this amount might be effective, but he did not think it would be so in severe years.

Rai Kailas Chandra Bose Bahadur agreed that large doses of quinine should be given for prophylactic purposes. Small doses absolutely failed to give the desired effect.

Major Glen Liston pointed out a statistical fallacy in Major MacGilchirst's figures. Major MacGilchrist had said that to ensure the taking of quinine he had instituted certain punishments. Those who came to the hospital with fever were fined. The fact that this was so, vitiated the figures he had put forward.

Major MacGilchrist, in reply to Dr. Bentley as to the impossibility of producing hæmolysis in healthy animals, said that the reasons for this fact were given in the paper. The state of a human body in which black-water fever was found was not healthy. According to Dr. Bentley the first dose of a specific hæmolytic serum produced phagocytosis and the second hæmolysis. Could the first dose not have produced acidosis which helped to produce the hæmolysis? He was entirely in favour of the administration of quinine for black-water fever but it would have to be guarded by administration of alkali. Dr. Bentley had referred

to but one symptom as being characteristic of black-water fever and had drawn attention to its resemblance to the same symptom in hæmorrhage ; Major MacGilchrist had referred to several symptoms resembling those of acidosis. The assumption of a specific hæmolysin was no explanation, and was a refuge for ignorance. With regard to Major Perry's remarks, he did not state that acidosis produced black-water fever; it was only one of three factors and, therefore, his contention was not applicable. Air-hunger was common in all acidosis diseases. In reply to Captain Berkeley Hill he said that depression sometimes followed the administration of quinine and he thought it was merely temporary depression due to nausea caused by the bad administration of quinine and the use of too soluble salts. This depression occurred before any quinine could possibly have been absorbed. With reference to Major Lalor's remarks as to Celli's method of administering 5 to 8 grains daily, he said that Celli himself stated that he got 8 per cent. relapses amongst those undergoing his own special treatment; the prophylactic treatment advocated by Major MacGilchrist showed less than one per cent. of relapses. As regards what Captain Hodgson had said, if he were not getting good results from administering 15 grains, he should look to the adulteration of the quinine for the cause. As regards controls, he had had warders as controls. With the warders, quinine was optional and they all refused it and none of them escaped attacks of malaria. Major Glen Liston had said that Major MacGilchrist's employment of punishment vitiated his statistics. This was not so, for prisoners could not work when they had fever, and there was a more severe punishment, than the slight one he inflicted, awaiting them if they did not complete their work daily. Moreover, none were actually punished: the warning during the first month was sufficient to produce the desired effect.

Quinine Propaganda.

Dr. C. A. Bentley, Special Deputy Sanitary Commissioner, Bengal, then presented his paper on Quinine Propaganda.

Attention was drawn to the fact that although India consumes at present about one-sixth of the world's supply of quinine, the vast proportion of the population which suffers from malaria receives no benefit from the remedy. A great deal of the quinine actually consumed also is wasted owing to the ignorance of medical men and the general public. So far the methods usually adopted to popularize quinine have largely failed to achieve their purpose. The pice packet system has led the poor to waste money fruitlessly. Quinine treatment in charitable dispensaries serves to demonstrate to sufferers from malaria the apparent uselessness of the drug owing to the inadequate dosage employed. The sale of quinine below cost price mainly benefits the well-to-do educated classes. The increased profits allowed to vendors of Government quinine, have failed to induce them to push the remedy because the demand for it is so small that the return they get does not pay them for the trouble of stocking and selling it. To remedy these he suggested the adoption of a system similar to that employed in Italy—selling quinine at a small profit, widely advertising it, and devoting the revenue obtained to grants of quinine to dispensaries, etc. In conclusion he pointed out the danger of a shortage of quinine in the future and urged the extension of cinchona plantations in India.

School Quininization.

The next paper introduced was by Major J. D. Graham, Special Malarial Officer, United Provinces, on School Quininization Experiments in the United Provinces. The following is a summary.

Systematic experimentation on quinine prophylaxis amongst scholars in district schools, as representing a good type of an organised community, was carried out in August, September, October and part of November 1909 in the Muttra district, in 1910 in the Buduan district, and in 1911 in the Meerut and Aligarh districts of the United Provinces, under the ægis of the Special Malaria Officer and district authorities, with two special sub-assistant surgeons as distributors in each district. Detailed reports which were submitted to Government and circulated in the provinces have enabled district officials to attempt, unaided, similar schemes, and in 1912 the District Boards of seven districts, in

the western United Provinces (the area of highest malarial incidence) were running schemes on similar lines without difficulty. By the circulation of a simple type of Quinine Register uniformity and accuracy of record, and regularity of administration were ensured, dosage being fixed on a scale calculated according to age, and quinine being given dry in uncoated tablets of grains ½, 2, 3, 5, washed down with water. A personal examination of all children at the beginning and end of the experiments enabled differences of splenic enlargement and incidence of fever, on quininized and non-quininized scholars, to be recorded and deductions drawn. No compulsion was used. Schools received dosage according to locality, city schools receiving about half that of schools in Khadir, riverain, or canal areas. Briefly, all the experiments showed a high degree of successful prophylaxis as well as definite therapeutic success, though this latter was not aimed at. In 1910 and 1911, 147 schools with 8,781 scholars showed a decrease of the splenic index of 54·5 per cent., a control of 1,978 non-quininized boys enrolled after the experiments had begun showing 20·6 per cent. of spleens in November at a time when the quininized showed 7·6 per cent. Again, without making any allowance for latent infection, irregular dosage, or defective diagnosis, all of which went to reduce any apparent failure, they in the 1910 and 1911 experiments failed to prophylax 9·3 per cent. of the pupils when 79·3 per cent. of the available quinine was consumed. Five hundred and ten teachers consumed 92·6 per cent. of the quinine available and showed 16 cases of fever, 4 of whom developed slight spleens. The figures prove that the more thorough the administration the less was the fever incidence and spleen development. Doses of grains 18 and 20 given twice weekly at intervals seemed most efficacious. Blood examination showed that many malignant infections were not, and that most benign infections were controlled, while the registers attested a high degree of temporary immunity during the experiment. The cost per pupil which was about 6·5 annas for the season could easily be reduced to 3·5 annas by relying entirely on local distributors. This demonstration of its educative, prophylatic and therapeutic value, of its feasibility, its cheapness, and its prevention of irregular school attendance, would indicate that the principle of its applicability, as a general measure in badly affected areas, should be accepted, while the advance made by the Buduan and Meerut District Boards, in not only running it unaided, but in being able to recover half the cost of the quinine by instituting a small fee for enrolment on the register, would indicate its general popularity.

The Discussion.

Dr. Rutherford, speaking on the free issue of quinine, said he was in favour of this. Quinine was largely given to children in schools in Ceylon.

Major Graham said that his attitude in regard to the free issue of quinine was that it should only be so issued in the presence of an epidemic. The demand varied from year to year according to the degree of malaria. The sale of quinine might very largely depend on this fact and therefore diminished sale should not be taken as condemnatory of this system of administering quinine.

Dr. Rutherford enquired what had been found the best means of administering quinine to children.

Major Graham said that he had found no difficulty in administering uncoated tablets of quinine of from ½ to 5 grains to children.

Dr. Bentley thought that the free distribution of quinine should be done through special agencies. His experience had been that quite young children of 3 or 4 years took tablets of the ordinary sulphate of quinine with comparative ease. Personally he preferred to use sugar coated tablets.

Latent Malaria.

Major Harvey then introduced the paper on the diagnosis of Latent Malaria, by Captain H. W. Acton, I.M.S., and Captain R. Knowles, I.M.S, and said—

The authors of this paper endeavour to give greater precision to the present methods. The paper is illustrated with charts which will have to be

specially drawn for future reproduction. They introduce the paper with a definition of latency and sub-divide the latency so defined into distinct phases. The latency of the incubation period needs no explanation. The period preceding recrudescence of the disease is however differentiated from that preceding relapse. The use of these terms recrudescence and relapse involves definition of their meaning. To explain this difference is not altogether easy. The occurrence of fever in malaria coincides with the production of schizonts in the asexual cycle. The cycle continues asexually with abatement of fever until it reaches the schizont stage again when fever reappears. If there is a long interval between the reappearances of fever under these circumstances that reappearance constitutes a recrudescence. Now if in the cycle of the malaria parasite sporogeny occurs, that is to say, sexual forms make their appearance in the peripheral blood to the exclusion of asexual forms, no fever can be produced, because the febrile manifestation takes place at a particular point in the asexual cycle. Supposing that under such circumstances a malarial febrile attack does occur, it is called a relapse. It is thought to be right in saying that the underlying idea in these definitions is that continuance of infection over long periods can take place either by (1) a continuance of the asexual cycle or (2) by a return from the continuance of purely sexual forms through parthenogenesis to reappearance, in numbers sufficient to cause fever of asexual forms. The authors apply two indirect tests for latent malaria, a condition in which the direct test is of little or no avail. These are the urinary urobilin test and the leucocyte count. Much stress is laid upon the fluctuations in urobilin output. The condition of the liver is a very potent factor in these fluctuations of urinary urobilin. The authors summarise their study in the following statements:—(1) The presence of urobilin in the urine in large quantities indicates that hæmoglobin is being destroyed. The blood destruction,—except in certain well defined diseases,—is due to destruction of erythrocytes by malarial parasites. If there is no fever present, the patient is in the latent stage of the disease. (2) In the latent period of relapse the asexual cycle is absent in the peripheral blood, and gamete formation is occurring. The urobilin consequently is diminished in amount, unless the functions of the liver are impaired, in which case urobilin may be increased. (3) The absence of urobilin from the urine indicates either that blood destruction is not occurring, or that the liver is still able to deal with the products of hæmoglobin destruction. In such cases other tests for latent malaria must be applied. (4) A leucopenia, of 2,000 to 7,000 per c. mm., or a leucocytosis, 16,000 or more, in the absence of other causes is suggestive of latent malaria. (5) A high relative mononuclear percentage is also suggestive that protozoal parasites are present. (6) A fluctuating leucocyte count, with a high mononuclear percentage at the leucopenic stage is very suggestive that malarial parasites are still present somewhere in the body. (7) The increase in the total mononuclear and hyaline cells is not a real but an apparent one, due to fluctuations in the number of the polymorphonuclear leucocytes. The tables given at the end of the paper showing the degree of association between the presence of urobilin in the urine and malaria are very interesting, so also are the various charts which accompany the paper, but which unfortunately could not be printed as they stood.

Dr. Bentley said that this paper showed that some very useful work had been done, but he objected to the theoretical part at the beginning of the paper. They had mixed up the clinical with the parasitological side. There was no more justification for saying that a person was suffering from latent malaria than that he was suffering from "latent" tape worm. We had no evidence that malarial parasites were ever latent. We might speak of disease being latent, meaning that symptoms were absent, but we could not apply this term to the parasite itself.

Malaria Prevention in Bombay.

Dr. J. A. Turner then introduced his paper on 'Malaria prevention measures in Bombay,' of which the following is a summary.

Bombay is situated on an island on the shore of the Arabian Sea in 18° 55′ N and 72° 54′ E. The climate is warm, equable and humid. The average mean temperature is 79° F., January being the coldest month with an average mean

temperature of 73·9° F., and May the warmest with an average mean temperature of 84·7°. The population of the city during the last census was 979,445. This only represents the fixed or permanent population. There is besides a floating population of about one lakh which consists of people of the labouring class who visit Bombay during the dry weather returning to their homes just before the onset of the rainy season. The average rainfall is 72 inches. The total area of the city is 22·53 square miles. The Public Health Department of the city is under the Executive Health Officer and two assistants. For administrative purposes the city is divided into seven wards, each of which is in charge of a Deputy Health Officer. The expenditure on the Health Department during 1911-12 was about 21½ lakhs, 5 lakhs of which is on hospitals alone. For the purposes of the registration of births and deaths and for medical relief the city is divided into ten districts with qualified Registrars, Sub-Registrars and trained medical inspectors. As early as September 1901, a committee of the Corporation was formed to consider the measures necessary for the prevention of malaria in the city. Reports were made on the prevalence of anopheline mosquitos in various parts of the city and suggestions made. In 1901, the chief varieties of anopheline mosquitos found in Bombay were—*Anopheles Rossi, Barbirostris, Jamessi, Culicifacies, Stephensi, Listoni.* In 1905, the Corporation asked Government to appoint a committee to enquire into the prevalence of malaria and other fevers. That committee was comprised of representatives of the Government medical service, sanitary service, mosquito experts and medical men. The committee sat for two years and issued a report. That report while dealing with the high mortality in the city, ascribed the high mortality to plague, stating that three-tenths of the deaths were due to plague. The report reads: "In our opinion the importance and the magnitude of this element (plague) in the unhealthiness of the city, places all other diseases in the back-ground and demands even greater attention than has of recent years been given to it." Thus the incidence of malaria fever up to 1908 in Bombay appears not to have been of sufficient importance to justify the committee in recommending any extraordinary malaria measures. Since the severe epedemic of 1908 and the report by Dr. Bentley on the conditions existing the importance of malaria has been recognised and in April last a special malaria officer (Dr. K. B. Shroff) was appointed in control of a special department. The officer has had a special training in tropical diseases at the Liverpool School of Tropical Medicine and a large experience in India.

In Bombay there are 4,380 wells in houses, 166 tanks, 4,887 cisterns, and the work of closing or hermetically sealing them is a task of great magnitude and difficulty, as this work is generally opposed on religious or superstitious grounds.

The measures adopted are—(1) The closing of wells and cisterns found to be breeding larvæ. (2) Treatment of all temporary pools and puddles with pesterine. (3) Giving a trial to fish before taking legal steps. (4) Distribution of quinine. (5) Filling in all hollow and low grounds with a view to remove potential sources of mosquito breeding and improve sanitation generally. (6) Improving of drains and gullies and extension of drainage schemes. (7) Improving the general conservancy of the city. (8) Teaching the public by handbills and lectures with magic lantern slides. (9) Taking action in Court. (10) The spleen census of children and the examination of blood. (11) A weekly return of cases of fever from public and private dispensaries. (12) The examination of all species of mosquitos found at all periods of the year. (13) Reclaiming the foreshore.

The task of controlling malaria in a city like Bombay is one of great magnitude such as has never been attempted before, and the paper points out the difficulties to be contended with, the obstacles to be overcome and the results achieved up to date.

The factors which conduce to endemic malaria are all present in Bombay:—(1) The mosquitos. (2) Breeding places, open wells, tanks, cisterns, new works, open channels and low-lying lands. (3) The people; 75 per cent. of the people are of the poor and illiterate class, ignorant and superstitious living under indifferent sanitary conditions, passively resistant and reluctant to take advantage of sanitary measures, the majority coming from malarious districts outside Bombay and returning to them yearly. The cry of religious

susceptibilities is heard amongst the educated as well as the uneducated when sanitation interferes with their prejudice or purse. (4) Climate is favourable in every way to the breeding of mosquitos. (5) Position.—Bombay is situated on an island adjoining other islands, and the mainland where ideal breeding places for mosquitos prevail and malaria is endemic.

Anti-Malarial schemes in the United Provinces.

Major Graham next introduced his paper on Anti-malarial operations in the United Provinces, and explained the various points dealt with therein by the aid of charts. The following is a summary of the paper.

The towns of Nagina and Saharanpur having been malarially surveyed and reported on by Robertson in 1909-10, and Kosi by Graham in 1910-11, were inspected by specially appointed committees in May 1912, the schemes considered, a report and estimate drawn up, and submitted to the local Government, and as a result the Irrigation Department have prepared detailed estimates of the projects as affecting them.

A. THE NAGINA PROJECT deals chiefly with tanks, waterlogging and wet cultivation. Rice and sugar grown on a waterlogged area, specially to the east and north-east of the town, with two rivers, a canal, many tanks, etc., produced three proved carriers, *culicifacies*, *fuliginosus* and *maculipalpis*. The committee's recommendations based on those of the malaria officer were—(1) Abolish rice within half a mile of the site and give compensation after enquiry. This the Collector is doing. (2) Flush the canal once weekly all the year and close a railway gul. This is being done. (3) Fill in with earth four small tanks at a cost of Rs. 2,416; fill in 14 others to a level to allow of drainage into the Pandhoinadi, by two new cuts, a north and a south, and deepen one tank in the centre and raise its sides with this material at a cost of Rs. 500. (4) Limit excavations for a mile outside the site, extend municipical limits to include brick fields, the railway filling up its own pits. Municipality should buy the tanks to gain the betterment from them when filled up. The total estimate of the Irrigation Department is Rs. 79,579.

B. THE SAHARANPUR PROJECT deals with defects due to over-irrigation by canals, waterlogging and wet cultivation. Rice and sugar cultivation round the site on ground waterlogged from excessive canal irrigation, with two rivers (Pandhoi and Dhamola) four drain escapes, four canals and four large pools in close proximity, and *culicifacies*, *fuliginosus*, *listoni* and *maculipalpis* as " carriers " are the features. The committee's report based on the Malaria Officer's scheme are briefly—(1) Stop canal irrigation within three-quarters' of a mile of the city edge, and prohibit sugar and high crops by bye-laws and provide for this at next settlement. (2) The railway to fill up its own tanks and pits, reconstruct an embankment and straighten a drain. (3) Municipality to acquire a marsh and tank, and fill up, level, and use them as building sites; also to legislate for excavations and brick burning within $1\frac{1}{2}$ miles of city, and adopt lift irrigation from wells in the Botanical Gardens. (4) Brick line 6,300 feet of the Karegi nala at a cost of Rs. 34,737, cunette about 4,000 feet of the Chilkhana road drain, and masonry line all not at present done at a cost of Rs. 9,539, masonry line the Pandhoi and Dhamola as indicated at a cost of Rs. 1,09,499. (5) Apply section 106, Municipal Act, regarding noxious vegetation. The total estimate is Rs. 1,58,017.

C. THE KOSI PROJECT deals with irrigation, deficient drainage and waterlogging. Surrounded by tanks the town site is waterlogged owing to defective drainage and proximity to the main Delhi-Agra canal which breeds out in enormous quantities, *culicifacies*. Many wells contained *stephensi*. Defective storm-water drainage through a syphon under the main canal caused stagnation, flooding and breeding grounds, though the large tanks showed marked absence of carriers. The committee's resolutions based on my report and about to be carried out are briefly:—(1) Water-proof the main canal bed for two miles near Kosi by puddling and cunette the bottom for two miles at a cost of Rs. 18,157, giving an eight-day flush if possible in the closed season. (2) Lower canal level opposite the town to enable Kosi town to drain directly into it, keeping the present connection for

winter or hot weather use. This will cost Rs. 32,287. (3) Divert Kosi branch drain one mile north of town and syphon it under main canal into the Kosi arterial drain at a cost of Rs. 24,858. (4) Fill up all tanks, except one large *pucca* one, to a level which will allow of drainage into the Ganda nala which is to be regraded and lined by masonry at a total cost of Rs. 61,775. Railway should fill up and drain all excavations and pits half a mile north and south of the site. (5) Fit certain wells with fixed iron tops and a hinged or sliding door and jug pumps. The estimate is Rs. 1,44,317.

The grand total for all these projects is about Rs. 3,80,000; Rs. 1,80,000 of which will probably be expended equally amongst the three schemes by the Irrigation Department before the end of the present financial year.

THE DISCUSSION.

Dr. Bentley wished to emphasise, as Dr. Turner had done, the difficulty of carrying out anti-malarial schemes in a city like Bombay. Legal powers were most important, but the necessary powers had not yet been granted. The absence of such powers necessarily delayed results. Dr. Bentley also congratulated Major Graham upon being able to show so much progress in anti-malarial operations in the United Provinces. He asked Major Graham for further information regarding the expenditure, and whether the estimate so far made covered the cost of compensation for the abandonment of irrigation. In some of the provinces in India, they could not look to spending such a large sum as one and a half lakh of rupees upon anti-malarial schemes for a town of only 7,000 persons. Although it would be very interesting to see the results of the work, he was afraid that if it was going to be so expensive it would be a long time before they could extend the work to a larger area.

Major Stokes asked Major Graham on what principle the towns where the operations had been undertaken in the United Provinces, had been selected. Had there been a sudden increase of malaria in them traceable to irrigation or were they in a condition of financial prosperity so as to render anti-malarial operations advisable in preference to measures dealing with general sanitation? He also wished to know how far Major Graham considered it desirable to urge special measures of a particular nature in a town where general sanitation was admittedly defective.

Dr. Rutherford enquired what cultivation Major Graham proposed to substitute for his wet cultivation as he was trying similar measures in Ceylon.

Major Graham, in reply to the questions put to him by the previous speakers, said that the towns in question in the United Provinces had been selected by the Lieutenant-Governor in consultation with the Sanitary Commissioner, Lieutenant-Colonel Chaytor-White, I. M. S., on account of high mortality from fever for a succession of years. He did not know whether any application had been made for increased legal powers in carrying out the operations. With regard to Dr. Bentley's question as regards compensation, Major Graham said that his figures did not include any estimates which the civil authorities may make later on with regard to the compensation for the cultivation. With regard to the question of the cultivation which was going to be substituted for the present cultivation of rice and sugar-cane, he said that this was not yet determined. He did not think there would be any heavy recurring expenditure as his estimates were for *pucca* works.

Major Harriss, I.M.S., Sanitary Commissioner, United Provinces, communicated the following, in reply to Dr. Bentley's question regarding the cost of the prohibition of irrigation at Saharanpur.

"It will be seen from the following note by the District Magistrate that it is extraordinarily small, while the loss of canal dues is *nil*, as more water will be available for distribution further down the canal."

Loss of Land Revenue.—The tract within which it is proposed to prohibit canal irrigation falls within the area of 15 revenue villages.

These 15 villages were divided at the last settlement among the assessment circles as follows :—

No.	I canal irrigated	6
No.	I not canal irrigated	1
No.	II canal irrigated	4
No.	II not canal irrigated	*Nil*
No.	III (all this circle is canal irrigated)	4

In these circles the standard rates used by the settlement officer were as follows :—

	Rausli Dakar.		Bhuda.	
	Wet.	Dry.	Wet.	Dry.
I canal irrigated	8	6	4	3
I not canal irrigated ...	6	4/12	3/8	3
II canal irrigated	6	4/2	3/8	3
II not canal irrigated ...	4	3/2	...	2/8
III	5	3	2/8	2

Thus the settlement machinery provided in this tract a standard for villages with, and villages without canal water, in each of the first two circles, and in these circles the remission of land revenue necessitated by the prohibition of canal irrigation would appear to be fairly represented by the difference between the revenue—at the settlement percentage of the whole—in the area affected, on the rental at (*a*) the rates used by the settlement officer, and (*b*) the settlement rates for land not canal irrigated in the same circle. In the third circle which has only the one—the canal irrigated rate—a correspondingly fair figure can be obtained by reducing standard rates by 25 per cent. on the analogy of circle I. So worked out, the loss in land revenue necessitated by stopping canal irrigation within the boundaries suggested by the committee comes—on the area affected—to Rs. 1,631-3-5 in each of the remaining 8 years of the current settlement."

Natural Enemies of Mosquitos.

In introducing his paper on "Some larvicides and natural enemies of mosquitos in Southern India," Mr. H. C. Wilson, Piscicultural Expert to the Government of Madras, said :—

The points I wish to bring forward in my paper are as follow.—(1) The habit of mosquitos, when egg laying, of avoiding waters where their natural enemies exist; the best method to adopt, to restrict the safe breeding grounds, is, in my opinion, to stock such places with suitable fish. (2) The necessity for properly constructed ponds in centres where permanent water can be obtained for the breeding and distribution on a large scale of the more important natural enemies of mosquito larvæ It will also be necessary to take some strong action to stop the wholesale destruction of small fish which goes on at the present time.

The Discussion.

Sir Pardey Lukis said he wished to ask some questions. One of the measures recommended by Major Graham in Kosi was the stocking of wells with *Ophiocephalus*. Mr Wilson said that these were the natural enemies of frogs which are destroyers of larvæ. Sir Pardey Lukis wished to know if Mr. Wilson considered that the *Ophiocephalus* was a good fish with which to stock wells and tanks.

Mr. Wilson considered that the presence of *Ophiocephalus* in wells and tanks was detrimental.

Sir Pardey Lukis asked for Mr. Wilson's opinion as regards fish of the genus *Barbus* with which he mentioned he had made some experiments. He had heard people in Madras say that this was the best fish to put into wells and tanks.

Mr. Wilson considered the smaller species of *Barbus* good larvicides and quite a useful fish to put into wells, but he had selected another fish which was very much better and travelled easily.

Major Graham said that the original recommendation as regards *Ophiocephalus* had been made before work with regard to larvæ-killing fish had been undertaken.

Major Glen Liston pointed out that a certain fish, *Rasbora damconia*, was described by Sewell and Chaudhuri as purely a vegetarian, he on the contrary had found this fish when young, a voracious mosquito larvæ eater but he was assured by Chaudhuri that when fully grown this fish became a vegetarian.

Mr. Wilson did not think this to be the case. Such a fish would continue, on attaining maturity, to eat larvæ.

Major Glen Liston enquired if Mr. Wilson had any experience of other creatures than fish, that lived in water and fed on larvæ. He had found that certain species of water boatmen and dragon fly larvæ were useful mosquito larvæ destroyers, while other species of these insects did not attack or feed upon mosquito larvæ. He thought more work was required to be done in this connection.

Mr. Wilson said there was a small water-flea mentioned in his paper, which attacked certain eggs, but he had not seen them attack mosquito eggs. The *Dytiscus marginalis*, in captivity, would seize and kill the *culex* larvæ, but he had not seen them kill any of the anopheles.

Sir Pardey Lukis said that Mr. Wilson and Messrs. Sewell and Chaudhuri apparently differed from one another as regards the *Chilwa*. Mr. Wilson pointed out that it must be a top feeder on account of the shape of its mouth, while Sewell and Chaudhuri said it was not.

Mr. Howlett said he had had some experience of the *Chilwa* and found it a good larvicide in captivity.

Mr. Wilson had never seen a frog catching a mosquito emerging from its pupa, but he had experimented with an ordinary mosquito on a small hook and had thus caught frogs.

Dr. Bentley thought this no criterion as he had seen frogs caught with the burning end of a cigarette on a hook.

Mr. Wilson, in reply to a question from Major Graham, said that *Ophiocephalus* when put into a well was certainly detrimental. When very young they would eat larvæ, but they grew very rapidly, and as they became big required something more substantial.

Major Perry said that his experience in the Jeypore Agency had been that the danio rerio and larvæ were never found together.

Major Lalor said—At the last meeting which took place at Bombay in November 1911, I announced the discovery of a parasitic biting fly of the genus *Ceratopogon* which infests malaria carrying anopheles at Kyaukpyu, and exhibited a specimen of the fly adherent to the nape of the neck of *Nyssorhynchus Fuliginosus* (the Kyaukpyu malarial carrier), with its proboscis deeply sunk into the eye of the mosquito. I have now to announce the discovery of what appears to be the adult stage of a mite, the larva of which is parasitic upon *Fuliginosus* and *Barbirostris* at Wuntho. This adult mite is parasitic upon one of three species of biting fly of the '*Psychodidæ*' group found at Wuntho, the observed infestation rate being 4 per cent. The mite in its nymphal stage appears also to be parasitic upon the same species of biting fly. A specimen of the adult mite detached from the fly and another of the adult in position on the fly are available for demonstration. In the latter specimen the fly has taken a meal of blood and it appears that the mite has abstracted the sanguineous contents of one of the intestinal diverticula.

This discovery is important, if correct (and its confirmation requires further research) as establishing a chain of indirect communication between the anopheles mosquito and the blood of man.

The only method of accounting for the presence of the adult mite on this fly is the supposition that, like the species of *Ceratopogon* described in my report upon malaria at Kyaukpyu, this fly preys upon the anopheles mosquito. Captain Patton who has been kind enough to examine the specimens has also kindly volunteered to transmit specimens of the larva, nymph, and adult to Professor Newmann for opinion as to whether these three stages represent a single species. *Prima facie*, there is reason for the supposition that this is in fact the case, since all three stages were found in the same locality.

THIRD DAY.—NOVEMBER 20.

The delegates re-assembled at the Council Chamber, Fort St. George, Madras.

Stegomyia and allied species of mosquitos in Bombay.

Major Liston introduced a paper by himself and Sub-Assistant Surgeon Akula on the distribution of *Stegomyia* mosquitos in Bombay. He said, *Stegomyia* surveys were being made in all the chief ports of India under the auspices of the Indian Research Fund. *Stegomyia fasciata* was the species of mosquito that has been incriminated in the New World as the carrier of yellow fever. In view of the approaching opening of the Panama Canal, when the endemic home of yellow fever will be brought into much closer communication with the Far East than it is at present, the degree of prevalence of this species of *Stegomyia* in the ports of India may, in the near future, become a matter of much practical sanitary importance. In Bombay in two months, 922 breeding places of mosquitos belonging to the sub-family *Culicinæ* were found. Fifty-one per cent of these mosquitos belonged to the genus *Stegomyia* or the allied genera *Scutomyia* and *Desvoidea*. By far the commonest mosquito of the group was *Stegomyia fasciata* whose breeding places were found 273 times. They were found all over the Island of Bombay. In every instance they were found in artificial collections of clean water associated with human habitations. The authors conclude their paper with the opinion that the climate and trade relations of Bombay are such as to favour the spread of yellow fever should the ports of the Far East become infected.

Stegomyia mosquitos in Karachi

Dr. Mhaskar then introduced his paper on the distribution and habits of *Stegomyia* mosquitos in Karachi. He said that very similar results to those obtained in Bombay had been obtained in Karachi in spite of the dissimilar climatic conditions prevailing there. After *Culex fatigans* which was found everywhere, *Stegomyia fasciata* of the culicines came second in extent of distribution. Here too it was only found breeding in clean collections of water near human habitations.

Stegomyia survey in Calcutta.

Major A. C. MacGilchrist next placed before the meeting the progress report of the *Stegomyia* survey in Calcutta, which will be found in the Appendix. The following is a summary.

Only two species of *Stegomyia* (*fasciata* and *scutellaris*) have been met with in the Port of Calcutta. It is noteworthy that *Stegomyia fasciata* is found only in densely populated areas. For this reason the term "domestic" as applied to it is not quite appropriate; it is too wide a term. *Stegomyia fasciata* is a town or city mosquito; it is not content to live in small villages such as occur on the banks of the Hooghly. In the Port of Calcutta this mosquito has so far been found only in the densely populated parts of Calcutta and Howrah and in a small area in Garden Reach. In Calcutta it is a very common mosquito in the northern part of the city—*i.e.*, north of Dharumtollah Street, including not merely the Indian residential quarter, but also the European commercial quarter and the Government Secretariat buildings. By Paiva it has been found common also in the "fringe area" of Calcutta, and especially in that part of the "fringe area"

adjoining the northern part of the city—*i.e.*, east of Upper Circular Road. We have been unable to find *Stegomyia fasciata* in any of the villages on the banks of the Hooghly below Garden Reach. *Stegomyia scutellaris* is exceedingly common throughout the port : it has no objection to either rural or city life. It does not object to live near a solitary isolated hut. While *Stegomyia fasciata* is seldom found breeding more than a few yards away from inhabited houses, *Stegomyia scutellaris* is often found breeding some hundreds of yards away. If, in Calcutta, a mosquito is found biting in the day-time, it is almost sure to be one of these two species. The only other species of mosquitos which we have found to bite in the day are *Desvoidea* ; they have been observed to bite occasionally in the late morning and early evening. The *Stegomyiæ* bite readily and frequently even in the middle of the day, their bite being more irritating and the result more conspicuous than those of other genera. Only in rare instances have *Stegomyia fasciata* and *Stegomyia scutellaris* been found in the same receptacle, and at first it was thought they might be antagonistic to each other. Their larvæ, however, when placed together seem to live quite peaceably ; the adults emerge side by side. Favourite breeding places for both species of *Stegomyia* are the broken earthen pots, containing rain-water, which are found so commonly around houses. *Stegomyia fasciata* has been found on the third floor of a house in the northern part of Calcutta in a very congested area. The larvæ are found wherever water can collect inside and in the immediate vicinity of dwelling houses. This species of *Stegomyia* seems to prefer small collections of water ; the eggs can resist drying for months. The larvæ have been found in receptacles holding only a couple of drachms of water which would all evaporate in a very few hours.

1. Measures suggested to destroy *Stegomyia fasciata*—

A. To diminish the number of their breeding places which are all provided by man, (*a*) movable receptacles, *e.g.*, earthen pots, etc., to be properly disposed of. Here the value of systematic concerted action on the part of the citizens would be immense. (*b*) Fixtures—Buildings and masonry structures. Engineers and builders—No hollows left capable of retaining water, mosquito proof lids to cisterns and other water receptacles, good drainage for rain and sullage water.

B. To destroy their larvæ—to provide a certain number of traps in which *Stegomyia fasciata* would lay its eggs and to breed for these traps a healthy stock of young larvæ of genus *Toxorhynchites*.

II.—Measures suggested to lessen the risk of the introduction of yellow fever.

Vessels coming from infected ports should not be allowed up the Hooghly within a certain number of miles of Garden Reach. The loading and unloading and quarantine station should be in as isolated a spot as possible—as far from large villages as possible, and no huts or buildings (other than those necessary for crews, passengers and cargo) should be allowed to be erected at that spot or within a certain radius of it. With yellow fever we have not got to consider latent infection and infection-carriers as we have to do in the case of malaria. Protozoal diseases are of two kinds—(1) The protozoa remain in the body after convalescence and so are capable of carrying infection after recovery from fever, *e.g.*, malaria, trypanosomiasis. (2) The cause of the illness disappears from the body with convalescence, *e.g.*, relapsing fever, yellow fever. So the above suggested measures, combined with fumigation, should eliminate the dangers so far as infected people and infected mosquitos are concerned. That infected mosquitos can transmit the infection to their offspring has not, so far as I know, been confirmed. If confirmed, the problem of preventing infected mosquitos' eggs, especially in a dried state, from reaching Calcutta would be a difficult one. I show you a tube-bottle in which a *Stegomyia* was enclosed and forgotten. Days afterwards the tube was casually examined. It contained the shrivelled body of a mosquito and on the wall and bottom of the tube were seen numerous *Stegomyia* eggs which must have been laid in a dry tube. Water was added to the tube and in a few hours numerous minute *Stegomyia* larvæ were wriggling about. It is interesting to observe the cap or lid at the broader end of the egg. This cap drops off when the larva emerges.

Stegomyia mosquitoes in Madras.

Captain J. H. Horne next read his paper on the distribution of *Stegomyia* in Madras, of which the following is a summary :—

Two species of *Stegomyia* occur in Madras Town, *viz.* :—(1) *fasciata*, (2) *scutellaris*, the former essentially a house mosquito, the latter apparently a wood or garden mosquito.

I.—*Fasciata* was found all over the town in varying numbers ; it was most abundant in the harbour and adjoining division of Georgetown. Its larvæ were taken in—(1) all sorts of receptacles containing water, (2) drains, open and underground, (3) wells, superficial and deep. None were found in open pools, ditches or bamboo stumps. Adults were almost all caught inside dwelling houses in the close vicinity of a breeding place. They bit both by day and night. Of their eggs some sank, others floated.

II.—*Scutellaris* was found breeding in—(1) receptacles containing water, (2) bamboo stumps, always close to trees. They have not been found in drains or wells or open pools. No adults were taken inside houses.

From these findings the following measures suggest themselves for stamping out *Stegomyia fasciata*:—(1) House-to-house visitation by a trained staff, and after due warning, fining of all in whose houses or compounds *Stegomyia* larvæ are found breeding. (2) Regular flushing of drains. (3) Closure of all wells not in use and covering of those which are.

Stegomyia Survey in Burma.

Major Lalor, I.M.S., also presented a brief report on the *Stegomyia* survey in the principal ports of Burma, which will be found in the appendix.

Yellow Fever mosquito.

Professor Howlett circulated a leaflet on the yellow fever mosquito, and said it was interesting to note that with the exception of Bombay, and perhaps Burma, earthernware vessels appeared to be the commonest breeding places of the *Stegomyia fasciata*. In Bombay, wooden tubs were apparently the commonest, and broken pots and earthenware vessels were of very little comparative importance. He would like to emphasize a point referred to in one of the reports, *i.e.*, in dealing with breeding places under city conditions, it was particularly important not to destroy all such breeding places. If all were destroyed in a given area the mosquitos would simply go and breed elsewhere and the total numbers would not be diminished, whereas if a certain proportion were left, these could be kept under supervision and control, and thus a great deal more could be done to reduce the actual mosquito population.

In reference to what Major MacGilchrist had said in his report about *S. Scutellaris* breeding up to a distance of 100 yards from human habitations, in Pusa he had found *Scutellaris* breeding in the jungle whether or not there were houses near by. All the *Stegomyia* at Pusa normally went through the hot dry weather in the egg stage, and eggs laid at the end of the rains lay unhatched until the succeeding rains. Eggs had been obtained at Pusa by crossing *Scutellaris* and *Fasciata*. The difference between *Scutellaris* and *Fasciata*, as regards their breeding places, was of interest because the *Scutellaris* in Pusa was essentially a bamboo stump breeder. By using cut bamboos as traps they had reduced the number of *Scutellaris* considerably in Pusa. The employment of earthenware pots as traps for *Fasciata* might be expected to have similar good results.

The Discussion.

Major Fry referring to Professor Howlett's leaflet in which he says that *Stegomyia fasciata* are very rarely if ever found away from human habitations, said that the specimens which he had sent to the Bureau at Kasauli were found in pools among rocks near a river, the favourite breeding place being a warm hollow in the rock standing well above flood-level, where the rain-water collects. Major Christophers and himself had found the same thing at the foot of the Simla hills. This tended to show that though the *Stegomyia fasciata* was normally a city mosquito, it did occasionally go afield.

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Captain Hodgson remarked that he had found *Stegomyia fasciata* in wells in Delhi, thus confirming Captain Horne.

Dr. Bentley said he had also found *Stegomyia* in wells in Bombay though he did not remember whether they were *Scutellaris* or *Fasciata*. A curious breeding place he had found in Bombay was the open troughs at the Grant Medical College into which the overflow of the laboratory went. All these harboured either *Scutellaris* or *Fasciata*. He had also found larvæ in places where there was just a thin film of water.

Dr. Rutherford said that the commonest places in which he had found *Stegomyia* breeding were the saggs of gutterings. In some parts of West Africa a law had been passed that all gutterings should be punched each lineal yard so that there should be no accumulation of water after rain.

Major Glen Liston confirmed Dr. Bentley's remarks as to *Stegomyia* being found in wells in Bombay. Out of 273 observations 8 per cent of the breeding places had been found to be wells.

Major MacGilchrist agreed with Professor Howlett, that a certain number of breeding places should be retained as traps and pointed out that he had suggested in his paper that these traps should be chosen so that they could be easily disinfected, or better still the larvæ of *Taxorhynchites* introduced into them. Observations in Calcutta had shown that *s. scutellaris* is exceedingly fond of wooden receptacles as breeding places. He confirmed Dr. Bentley's remarks as regards the small amount of water required for the breeding of the species *fasciata*.

Dr. Bentley enquired if any experiments had been made regarding the viability of *Stegomyia* eggs.

Professor Howlett mentioned in reply that he had experimented with *Scutellaris* eggs at Pusa, and had found that these eggs when deposited in water might not hatch for several months. Again, he had been able to keep eggs quite dry and hatch them after ten months had elapsed; some of these eggs were still being kept and might hatch later. The same batch of eggs may hatch out at very irregular intervals. He thought this was a point that would bear investigation.

Major MacGilchrist had kept eggs of *S. fasciata* dry for a month and then hatched them out.

Professor Howlett, in reply to a question by Dr. Bentley, said that he did not think that eggs floating hatched any more quickly than eggs that had sunk.

Dr. Mhaskar confirmed Professor Howlett's statement with regard to the hatching of the same batch of eggs at irregular intervals.

Major Perry said that he had not come across *Stegomyia* so frequently in villages as in the jungle.

Captain Patton had often seen calves bitten by *Scutellaris* at Guindy. He thought it was of importance to know something about the food of *Scutellaris* and *Fasciata*, respectively.

Captain Horne thought Major Perry's observation on the rarity with which he had found adult *Stegomyia* in villages was interesting, in that it showed that the species was in all probability *Scutellaris*. In Pusa this mosquito was distinctly a house mosquito. In Madras he had not been able to find a single adult *Scutellaris* inside any house or hut, although they were in some cases found within six feet of the doors.

Insect Psychology.

Professor Howlett, Imperial Pathological Entomologist contributed a paper on Insect Psychology, of which the following is a summary.

Experiments on the blood sucking cattle fly *Stomoxys* indicated that it laid its eggs, not with any conscious maternal forethought, but simply as a blind and unreasoning response to a certain smell. On following up this line with a species of fruit-fly which is a serious pest in some parts of the country, it was discovered that the female emitted a smell resembling ordinary citronella, and that males

could be caught in very large numbers by baiting traps with citronella, since they came to the traps and remained there apparently under a blind impulse to follow the scent of the female. Assuming from these experiments that such reactions are of general occurrence, we must regard insects, not as intelligent beings consciously shaping a path through life, but as being in a sort of active hypnotic trance. The sexual relations of mosquitos are being investigated, and the suggestion that the male found the female by its antennæ being tuned to respond to the particular musical note of her hum was one which seemed to promise some results, though no definite assertions could yet be made. Mosquito bite is, it is certain, very largely controlled by temperature, in the sense that a female mosquito will generally attempt to bite with avidity at any surface, even a glass tube, if its temperature lies between about 35° and 45° centigrade. This fact will in all probability enable us to get information as to the physiology of mosquitos since it gives us a method whereby we can get them to suck up hot solutions of various drugs which could not be administered if at ordinary temperatures. If the view of insect psychology here outlined be a true one, it shows one way in which the entomologist could assist progress in the study of the insect carriers of disease, and opens up great possibilities in mosquito control. Once we discover the stimuli or particular conditions which determine a mosquito's actions, we hold the key of the position, since we can then apply our knowledge to the mosquito's undoing. It is no intelligent foe we have to fight, but a mere battalion of somnambulists.

The Discussion.

Major MacGilchrist wished to ask if the attractive power attributed to temperature might not be connected with ætherial vibration, or body vibration. Also whether it was not possible that the repulsive effect of a cold body might be due to the mosquito's disappointment when trying to bite cold bodies.

Major Fry thought there was no reason for Professor Howlett being disappointed with the result of his experiments with citronella and the fruit-fly. Professor Howlett should be satisfied if he could by this means collect one sex and thus reduce the numbers.

Captain Mackie wished to enquire, on behalf of Captain Cragg, regarding any effect likely to result from the fact that insects in India were all more or less at the temperature of the human body.

Professor Howlett, in reply to Major MacGilchrist said that there did not appear to be any repulsion from a cold surface, but simply indifference to it. He thought there might be something in Major MacGilchrist's suggestion as to vibration, but in a rather different sense. Some effect might be attributed to the pressure of light, and he had calculated that with a very small insect the pressure on the wings from this cause might be about one five-thousandth of the insect's whole weight. As regards the citronella experiments with the fruit-fly, the results were not entirely disappointing for they had succeeded in largely checking the incidence of the fruit-fly pest. The difficulty of preventing all pairing was however almost insuperable in practice in the field. Professor Howlett said that Captain Mackie's question regarding the temperature of the air and the body was a pertinent one, but he believed he had found that when the temperature of the air was at or above that of the body mosquitos did not bite. The experiments opened up a number of questions with regard to specific "temperature indices" which required a great deal of further work.

Captain T. C. McCombie Young, said :—

May I draw attention to the prevalence of *Stegomyia* on the river steamers that ply on the Ganges and Brahmaputra. *Stegomyia* breed in large numbers in the bilge water of these boats and the holds swarm with clouds of adult mosquitos. In addition to the infestation of the steamers themselves, the receiving flats at the various river ghats and the country boats which ply on these rivers are also infested. Their extermination is easily accomplished by clearing out the bilge water, and by burning sulphur in the holds and cabins with all air apertures closed. Considering the large passenger traffic on these

boats, the matter is worthy of consideration, if any legislative measures are contemplated, as it might prove a factor in the dissemination of the disease if it were introduced in the port of Calcutta.

Etiological relationship of seven-day fever.

Major O'Gorman Lalor next introduced his paper on the etiological relationship of seven-day fever, of which the following is a summary.

If we could show that there exists an etiological relationship between seven-day fever and yellow fever to the extent that the infective agency in these two diseases is identical and that its operation is similar in both, we should be able, as long as seven-day fever persists in the great seaport towns, and especially at times of seven-day fever prevalence, to assert a definite risk of the dissemination of imported yellow fever, and the possibility possesses sufficient intrinsic importance to justify us in inviting attention to it. After instituting a comparison between the geographical and seasonal peculiarities of these diseases supplemented by a further comparison between the symptoms and physical signs of both, detailed suggestions were made for experimental proof or disproof of the possibility mentioned. *Primâ facie* it would appear to call for early investigations, since, if true, it will incriminate "*Stegomyia fasciata*", as the carrier of seven-day fever. That mosquito being the established carrier of yellow fever the point of Major Lalor's remarks is as obvious as it is important.

Kala Azar.

The Hon'ble Surgeon-General Bannerman presented the following report on the operations of the Kala Azar Committee.

At the first meeting of the Scientific Advisory Board elected by the Governing Body of the Indian Research Fund, a committee for the study of Kala Azar consisting of Surgeon-General Bannerman as Chairman, and Major Christophers and Dr. Bentley as members, was appointed. This committee met accordingly in Bombay on the 17th of November 1911, and resolved that the following work should be started at once:—(1) An investigation into the etiology of Kala Azar with the object of ascertaining how the disease spreads. (2) An enquiry into the distribution and prevalence of Kala Azar in India so that scientific investigation may be facilitated, and also with the object of guiding preventive action.

(2) The committee proposed that Captain Patton, I.M.S., should work at the first problem in Madras, and that the survey of Assam should be entrusted to another I.M.S. officer. The officer selected was Captain F. P. Mackie, I.M.S., who was deputed to Madras to study Captain Patton's technique before proceeding to Assam. He arrived in Madras on the 18th March 1912 and remained there till the 2nd May when he left for Assam to take up the work arranged for in consultation with the Government of that province.

(3) About the same time the Scientific Advisory Board were able to depute Dr. Korke, M.B. (Edin.), who had been specially trained under Sir Ronald Ross at the Liverpool School of Tropical Medicine, to assist in the work.

(4) Accordingly I convened a meeting on the 28th of March in Madras of these three workers, and it was decided to attack the epidemiological problem first and to leave the mapping out of the disease throughout India for a later period and the work was apportioned among them as follows. (1) Captain Patton was to repeat his experiments with bugs and every other sort of insect at all likely to have anything to do with the spread of Kala Azar in Madras. (2) Captain Mackie was to work at the King Institute, Guindy, endeavouring to infect animals, so as to discover a susceptible animal with which to do transmission experiments, and with the idea—strongly impressed on his mind by his experience with the Sleeping Sickness Commission under Sir David Bruce in Africa—of discovering a "reservoir" of infection of Kala Azar. He was also to carry out feeding experiments with body lice as he had become specially familiar with the anatomy of these insects when working at the etiology of relapsing fever in Bombay. He was also to endeavour to make cultures from the blood of human beings and the domestic animals in Madras. (3) Dr. Korke was to take up the epidemiological side of the question, and to devote his

attention to the endemic areas in Royapuram near the Medical Stores and Monogar Choultry Hospital. He was given facilities at the Royapettah, Royapuram and General Hospitals for clinical investigation nd furnished with a small laboratory at the latter institution. The results of th se investigations are set forth in the progress reports to be read at this meeting.

(5) Captain Mackie had to leave Madras before a suitable case presented itself for the inoculation of the various animals he had collected, and consequently they were left with Captain Patton who carried out the actual experiments. He, however, conducted a few similar ones in Bengal, the results of which are stated in his paper. His experiments with body lice proved negative. The lice were fed on patients having parasites in the peripheral blood, they were kept at a suitable low temperature, but the search for developing parasites proved negative.

(6) Dr. Korke's epidemiological investigations have been laborious, and though not of course as yet conclusive, have opened up fresh fields which will have to be thoroughly explored by him in the future.

(7) The paper by Colonel Donovan, I.M.S., clearly shows that there may be other theories of infection besides the popular one of insect convection, that must be considered. Captain Patton's work is set forth in his two papers, the main contention in the first being that a certain definite temperature is required for the full development of the parasite in the bed bug; the second contending that the disease in Madras is probably not of animal origin.

(8) In connection with the discovery by the Sleeping Sickness Commission that an animal may be actually a reservoir of this disease, while at the same time showing no parasites in the blood, we may well reserve our opinion as to the theory held by some that the dog in India may be connected with the spread of Kala Azar. Though over 2,000 dogs in Madras have been examined for Kala Azar parasites by means of spleen and liver smears with negative results, this may not mean that the dog is immune to Kala Azar infection. Colonel Donovan has shown that a puppy treated by inoculation of spleen juice into the liver contracted the disease, as proved by the presence of Kala Azar parasites in the bone marrow, though smears made from liver and spleen proved negative.

Kala Azar—Distribution and Modes of Infection.

Lieutenant-Colonel C. Donovan next introduced his paper on Kala Azar, its distribution and the probable modes of infection, of which the following is a summary.

The disease in India is endemic in Calcutta and the districts round about in Assam and in low-lying districts of the deltas of the Ganges and Brahmaputra. The epidemic character of the disease in Assam doubted—may this not be malaria?

Is Kala Azar present in Orissa? This would be an interesting fact and might explain the presence of Kala Azar among coolies on the tea gardens in Assam. The coolies, I understand, are chiefly imported from Orissa.

In the Madras Presidency the disease is endemic in Madras City; in the *mofussil* a few cases have occurred in Madura, Negapatam and Cuddalore.

Probable modes of infection may be divided into two—

(1) By means of insects, and (2) By oral infection.

(1) *By insects*—(*a*) *Bed bugs.*—Patton has brought very strong evidence to bear on the transmission by means of these insects; his recent attempts at single feeds are of much interest, but we require confirmation of his experiments. A very recent attempt by Patton to repeat his previous success has, I believe, failed, doubtless due to unfavourable conditions.

(*b*) *Conorrhinus.*—No results obtained. An interesting insect, as a species of the same genus implicated in human trypanosomiasis in Brazil. Popular belief is that *Conorrhinus* feeds on bed bugs; a similar belief is held in Europe with regard to *Reduvius personatus.* Could these *Reduviids* procure the blood second hand?

(*c*) *Mosquitos.*—Very little work under this head. In places where Kala Azar exists, there too malaria prevails : for instance, in Assam, in Lower Bengal and in our City of Georgetown.

(*d*) *House-fly.*—Incriminated as acting as a transmitter. The presence of a flagellate in the alimentary tract of the fly lends some colour to this suspicion, but the *herpetomonas* of the fly is a flagellate *sui generis.*

(*e*) *Lice and ticks.*—Tried on a small scale and found ineffectual.

(*f*) *Fleas and dogs.*—In Europe dogs are found to harbour Leishmania, and the dog-flea is accused of transmitting the flagellate to men. So far no Leishmania found in dogs killed in Madras. Recently a dog was infected by a massive injection of splenic blood taken from a Kala Azar patient. The dog was killed about three months after the blood was injected ; the marrow taken from ribs contained Leishmania, but the spleen and liver contained no parasites. The bone marrow was examined previously in a very few cases. A further examination of the bone marrow of the dogs of Madras City is called for.

(2) *By oral infection.*—In a fairly large proportion of Kala Azar cases the disease begins with signs of intestinal involvement simulating typhoid fever. In the course of all cases, there are periods of diarrhœa and dysentery. In fatal cases ulceration of large intestines marked, a suspicion of a primal attack of the intestinal mucosa. Could *Anchylostomœ* and *Trichomonads* act as carriers ; that is, could Leishmania be a commensal ?

Is Kala Azar in Madras of animal origin ?

Captain W. S. Patton next introduced his paper " Is Kala Azar in Madras of animal origin ?" The following is a summary.

The monkey " *Macacus sinicus* ", can be infected with the parasite of Indian Kala Azar only when inoculated with large doses ; it is possible that very young animals may be more easily infected. The dog for all practical purposes is refractory ; when inoculated with large doses it may become infected. The examination of street dogs destroyed during the last seven months in the lethal chambers of Madras has failed to show a single naturally infected animal. Kala Azar in Madras is therefore not of canine origin. The jackal (*Canis indicus* ") is similarly refractory and cannot therefore play any part in the transmission of the disease. The domestic cat cannot be infected even with large doses. Kala Azar in Madras therefore cannot be of feline origin. The white rat is also refractory, and so far the parasite has never been seen in the hundreds and thousands of rats " *Mus rattus* " and " *Mus documanus* " which have been examined in connection with plague. The goat, the calf and the pig are totally refractory. As the monkey is not wild in Madras it cannot possibly be the natural reservoir of the parasite. Kala Azar in Madras then is not of animal origin but is transmitted from man to man, that is, it is of human origin.

Development of the parasite of Kala Azar in the bed bug.

Captain Patton next introduced another paper on further observations on the development of the parasite of Indian Kalar Azar in the bed bug. The following is a summary.

I take it for granted that the main object of research work in connection with Kala Azar is to find out exactly how the parasite is transmitted to man, and in bringing this problem before you, I wish to draw your attention to certain points connected with its solution. In the first place I want you to assume with me that the parasite is an insect flagellate, and that it belongs to a group of forms which at the present day are widely distributed in nature. These flagellates occur in Diptera, Fleas, Lice, Bugs, and Hymenoptera, and the number of species which are infected is very large. I wish to direct your attention to certain fundamental facts connected with them.

(1) The methods by which they are transmitted from one insect to another are very numerous. Some insects acquire these flagellates in their larval stages, others again become infected both in their larval and nymphal stages, while many ingest them in their adult stages.

(2) Their life histories follow a uniform type consisting of a series of multiplicative changes which culminate in the formation of the round stage, the post-flagellate; this is the infective stage.

Now in considering the life histories of these flagellates, I want particularly to draw your attention to one point, and that is, we can neither understand the changes these parasites undergo in their insect hosts, nor give a reason for these changes, if we look upon them merely as cultural forms; that is to say, if we isolate them from their hosts and cultivate them, we cannot expect to find the same changes going on as would occur in the insect host. You all know that the malarial parasite, in order to undergo its sexual cycle must be brought in contact with the alimentary tract of a certain insect or small group of closely allied species. In short it is a specific reaction. Exactly the same holds good in the case of the flagellates of insects; I know of no exception. Let me give you an example. The flagellate of the house fly, *Musca nebulo*, will not undergo its life history in the green bottle, *Lucilia serenissima*, yet these two insects feed side by side on the meat in the bazaar shops. The reverse is also true, the flagellate of *Lucilia serenissima*, will not live in the house fly. In the same way the flagellate of a flea will not live in a louse, and *vice versa*. I could multiply instances, but these will suffice.

Now we may well ask what does this mean? I will try and tell you in what direction I look for the answer.

Those of you who have studied the alimentary tracts of insects will know that there is considerable variation regarding its structure. In some forms before the food passes into the mid-intestine, there is a preparatory phase in which the food is broken up in the crop, in others there is no crop, and the bulk of the digestive changes takes place in the mid-intestine. Now almost all the insects which are infected with flagellates have no true crop, some feed on organic matter in water, others on animal and human excrement, some on human food, and still others on human and animal blood. Here then we have a great variety of parasites living in insects whose food is of the most varied kind, and they have adapted themselves to these conditions. Now we are told that the alimentary tracts of blood sucking insects are nothing more or less than culture tubes containing rich haemoglobin medium. Such statements would lead the unsuspecting observer to believe that these flagellates will live and multiply in the alimentary tracts of any kind of insect, and not in one particular insect or group of insects which are closely allied; that is to say, there is no specific reaction whatever that may be, between one insect and its flagellates, but it may be common to widely divergent forms. I believe this is far from the truth. I would point out to you that this question is not merely of academic interest, for the whole of our preventive methods in the case of insect borne diseases depends on this knowledge. If, for instance, the parasite of malaria will react and complete its life history in the alimentary tract of any kind of dipteron sucking the blood of man, we will perforce have to alter our anti-malarial campaign. Again, if the flagellate of Sleeping Sickness will multiply and complete its life history, not only in one or more species of tsetse fly, but in other species of diptera, in bugs, fleas and lice, we would be faced with a preventive campaign well nigh impossible. I could multiply these examples by referring to the protozoal diseases of animals.

I would therefore again repeat that the alimentary tract of a blood-sucking insect is not a culture tube, and what is more it can never act as such. There is no greater fallacy than to think that under certain unknown conditions the alimentary tract of a blood-sucking insect may react as such on the, so-to-speak, foreign protzoon which may accidentally enter its mid-intestine, and cause it to be stimulated into activity. What, may I ask, are these unknown conditions? Those who speak of them leave us in the dark. The alimentary tract of an insect is a living organ in which vital processes take place. There are further no facts, as far as I know, to show, for instance, that the digestion of blood in a louse is the same as that in a flea, or that in a flea similar to that in the bed bug. My colleague, Captain Cragg, has recently been studying the digestion of blood in a species of *Tabanus*, and he has found that it is a complex process. I do not intend anticipating Captain

Cragg's work, he will in due course describe his observations. I venture to predict it will open up an important biological problem, for at present we know very little regarding the effect of digestion or any change in digestion on the parasite of an insect; the many obscure points which at present we cannot explain, will in all probability be clear when we know more about normal and abnormal digestion in insects. I therefore maintain that the relationship between the insect, and its parasite is not a casual or accidental one, but is dependent on a number of definite factors which are peculiar to the digestive processes in that insect and that these factors govern to a large extent the life history of the parasite. So to-day we have specific invertebrate hosts for the protozoal parasites of man and the lower animals.

The flagellates of insects are a well defined group or groups whose period of mutability has ceased, so that the species of one group will not pass into the species of another. It is important to bear this in mind. On the other hand there is evidence that their life process may be disturbed, so that an actual change of host may take place. There is a common flagellate in the alimentary tract of *Culex fatigans* in Madras, which passess into the mosquito by way of the larva. You know that the larva lives in water, and feeds on the small animalculi and other minute forms which it finds in the water. The flagellate has apparently an ideal food, for it rapidly multiplies and grows into a flagellate, and when the male or female mosquito hatches out they will be found at the lower end of its midgut. After a short time the female mosquito takes a fill of blood from man or some animal, and the flagellate in a non-resistant stage is suddenly brought into contact with a complicated organic substance. What is the result—either the parasite must be destroyed or else it must so modify its life history that when it comes in contact with the blood it will be in a condition best able to resist any injurious effect. This is what happens to the flagellate in the female mosquito, fresh blood destroys it in a short time. Dr. Bentley when at Bombay kindly shewed me the mid-gut of a mosquito, anopheline I think, which was packed with the round stage of one of these flagellates. I must confess that I could not say what these bodies were until they were stained; I had never seen the condition before. The form in *Culex fatigans* always rounds up in the hind gut and rectum of the mosquito. This then seems to me to be one of the lines along which these flagellates of mosquitos may very well alter their life histories chiefly as a result of the injurious action of fresh blood on the flagellate stage. It is not difficult to understand how in time they may leave the alimentary tract of the mosquito and then pass to the salivary gland. Miss Robertson in Uganda has recently pointed out that a bug *Loptoglossus membranaceus, Fabr.* which feeds on a gourd-like creeper, is infected with a natural flagellate, and that in the adult bug the salivary glands are nearly always infected with the parasites; the nymphs never shew them there, as the infection works forwards as the bug develops. Miss Robertson states "I should like to point out that it has a certain interest to find this state of affairs in Uganda involving a parasite of the same genus as that which produces the diseases of Kala Azar and Oriental Sore." I consider this a most important observation for it shews that certain factors have come into play resulting in a disturbance in the life processes of this flagellate, and it is seeking an outlet in another direction, though at the same time being regularly transmitted in the usual way from bug to bug. It is not difficult to understand how under suitable conditions such a flagellate may be transferred to a plant. I would thus explain the presence of the flagellate in Euphorbia. This is the light in which I have long seen the parasite of Kala Azar. It was once an insect flagellate passing its complete life history in its insect host. In the process of time some disturbing factor was introduced which was a serious obstacle to the parasite. Perhaps its host passed from ingesting vegetable food, or insect juices to the habit of blood sucking. *Conorrhinus rubrefasciatus* appears to be a case in point of how such a change takes place. If you study the habits of this bug, you will find that it behaves exactly like many predaceous bugs; in Mauritius it is said to be entirely a blood sucker in all its stages. I have no proof that this is the case in Madras.

The interesting circumstances I have referred to, have led the parasite of Kala Azar to alter its life history so that it has now passed into the body of the

host of its insect host. Here it has become an intracellular parasite. This stage is now fixed, and the insect phase, as in the case of the flagellate of Euphorbia, has become obscure. Nevertheless it is still able to pass into its insect host, and complete its life history. This can only take place provided the conditions are suitable. As far as I know at present these may be as follows :—

1. The stage in which its insect host is at the time the parasite is ingested.
2. The temperature of the air surrounding the insect host.
3. The necessity of an interval to allow the flagellate stage to pass on to the post flagellate.

I have been attempting to solve the problem along these lines. I have already found out the importance of the third factor, the destruction of the flagellate stage by fresh blood in the stomach of the bug, and it seems to me to indicate the line along which the parasite has evolved; it suggests that blood has not been in the past, and is not at present, the medium in which the flagellate stage was and is accustomed to live and multiply. Consider then what a serious obstacle this must be in the way of the parasite completing its life history.

The second factor is the temperature at which the host is at the time the parasite is flagellating. The parasite of Kala Azar is unable to leave its leucocyte carrier and to pass on to its flagellate stage, until the leucocyte is digested; in its human stage it is non-motile. At high temperatures the digestion of the blood in the bug is markedly accelerated, at lower temperatures it is retarded. There is therefore a certain limit of temperature required, so that when the parasite is freed, it can not only flagellate, but can obtain sufficient nourishment to multiply; and at the same time the bug should not be ready for another feed. I have endeavoured to arrive at that temperature in my second paper. I have not, however, as yet taken accurate thermographic records of the range of temperature of Madras during the months of December and January.

The last factor is the stage of the bug when the parasite is ingested. As you know the bug passes through a series of changes from the larval stage to that of the adult. It may feed once, twice or three times between each change, and the condition of the stomach with a partially digested meal is different to the condition in which it is with a completely digested meal. A partially digested meal followed with a fresh one offers the parasite, already in the stomach, a much better chance of completing its life history; especially is this the case when the bug is just about to change from one stage to another, for then digestion is almost completely stopped. Further, the digestion in the adult stage is much more rapid than in the nymphal or larval stages.

Assuming then that the parasite of Kala Azar is an insect flagellate, we can consider the following points.

(1) The parasite is scantily present in the circulating blood, at times it is numerous.

(2) It is, so to speak, a prisoner until it is freed, it can then only flagellate and multiply when the conditions in the bug are exactly suitable; I have outlined these conditions.

(3) Though it is probable many bugs ingest the parasite, only a very small percentage can ever become infective.

(4) The peculiarities well known regarding the disease and its spread, in Madras at least, appear to me to fit in with the hypothesis that it is insect borne, and that that insect is the bug.

An investigation into Kala Azar.

Captain Cragg then read the following short note on an investigation into Kala Azar :—

Captain Patton has mentioned some work on which I have been engaged, in connection with the processes of digestion in the blood-sucking flies, and perhaps it will be well if I give some account of it here. My observations are not nearly complete and I have no intention of making definite deductions as

to the results, at the present stage, but the appearances which I have seen are very suggestive, sufficiently so as to indicate that there is a wide field of work on this matter, one which is particularly interesting to us in view of the possibilities, which it suggests, in the life histories of those protozoa which alternate between a vertebrate and an invertebrate host.

Before speaking of my work I would like to indicate the line of thought which led up to it, and the end I had in view. I may say at once that I have regarded entomology as an accessory science only, and have looked upon the anatomy and physiology of the insect from the point of view of the parasite which it may contain or convey. Now, take the case of any parasite which is taken up with the food of a blood-sucker. In many cases, of which the malaria parasite is an obvious example, we know that, given the suitable host, the protozoon undergoes certain changes which have for their ultimate aim the propagation of the species. Theoretically, if the conditions were perfect, and we might easily suppose them to be so in cases in which the blood of the vertebrate hosts contains a large number of parasites, all the potential invertebrate hosts would become infected and infective, but we know that this is by no means the case. Captain Mackie informs me that only 5 per cent. of *Glossina palpalis* fed under the most suitable conditions become infective, and I have heard, though I cannot recollect on what authority, and am inclined to doubt it, that 15 per cent. is the proportion of *Anopheles* which become infected in the case of malaria. It is evident that we have here some unknown factor, which renders the environment of the parasite so unfavourable that only a small proportion of those ingested can complete their development. If we could determine this unknown factor we would, I am convinced, be well on the way to solve many perplexing problems in parasitology and epidemiology. It can hardly be simple chance, for the numbers are too large; indeed it is evident that the enormous numerical increase which takes place during the sojourn in the invertebrate is intended to compensate for the action of some unfavourable influence. Many possibilities suggest themselves, such as especial vigour on the part of some individuals out of each batch, lack of suitable food supply, the element of chance in the collision of the male and female elements, but I do not think that any or all of these are sufficient to account for the undoubted fact that only an extremely small proportion of ingested parasites reach maturity.

It appears to me that an examination of the environment of the parasite, after it has been ingested by the fly, is a necessary preliminary to attempting to determine this factor, and this led me at once to the study of the digestive processes in the blood-suckers. This is not the place to discuss entomological problems *in extenso*; I will only indicate briefly the direction to which my observations point, without going into detail, more especially since my work is by no means complete.

For the study of the changes which the alimentary tract undergoes during the digestion of blood, I selected a large species of *Tabanus*, as being fairly convenient to handle, and having a simple anatomy. My method was to feed the flies on cattle, and subsequently, at intervals of from five minutes to three days, to dissect out the whole of the alimentary tract and to cut it up into serial sections. The labour involved may be judged from the fact that I have now about 300 slides of serial sections.

The only part of the gut to which I wish to refer at present is the midgut in which the important digestive changes take place. I need not describe the structure of the organ further than to say that it only differs from the corresponding part of the mosquito, with which you are all familiar, in having the columnar epithelium thrown into villi, so that the lumen of the organ, when it is empty, has a stellate outline; the cells of the epithelium are also longer than those of the mosquito. In the resting condition the striated border, the vacuoles and granules internal to the nucleus, all correspond to the conditions described in *Anopheles*.

When a fly has had a full meal of blood, the midgut is distended to many times its previous size, and one would be prepared to find considerable alterations in the epithelium as the result of simple distension. Christophers stated many

years ago that the epithelium of the midgut of the mosquito loses its columnar shape and becomes flattened when the organ is full of blood, and this occurs also in *Tabanus*. But the folding of the wall into villi renders the gut in this case more distensible, and the whole of the feed is passed at once to the gut, and not delayed in the crop as is the case in the mosquito.

I was fortunate enough to obtain for some of my experiments some *Tabanids* bred from the egg by Captain Patton. From one of these I prepared a series of sections showing the condition of the gut within five minutes of the first feed, and here I found a condition of affairs which was somewhat unexpected. I cannot here describe the appearance of the midgut in detail, but it amounts to this, the whole of the epithelium is in process of desquamation, the cells being thrown off into the lumen and their place taken by new cells developed from the small nuclei which are always to be found, as in the mosquito, between the columnar cells. The desquamation does not take place simultaneously all over the gut, but commences at the posterior end, so that by looking through a series of sections one can see all stages of the process. At the upper end there is a region where the gut is almost unchanged, and below this a region in which the villi are depressed, and the cells pushed in little bunches towards the lumen, many degenerated cells being in the act of separating from their fellows. Further down still there is a definite layer of degenerating cells separated from the epithelium and external to the blood in the lumen, while in the middle and posterior parts the whole of the cells of the epithelium have been thrown off, and are replaced by small flattened cells developed from those which were originally between the columnar cells of the resting epithelium.

It is impossible to convey an accurate picture of the change without very numerous drawings of the actual specimens, but if we do not stretch the analogy too far, we might compare the throwing off of the epithelium to the changes in the uterus during menstruation. The analogy is useful in explaining subsequent events, for, as in the case of the uterus so here too a new epithelium is produced, which comes to have the same appearance as that of an unfed insect, at least on a superficial examination. The cells become first cubical, then columnar, and finally as the mass of blood gets smaller, collect into villi, until in 72 hours or so the insect is ready for its second feed. I will not go into further histological detail at present.

These remarkable changes do not occur in quite the same manner in flies which feed a second or third time, but I am not at present in a position to offer a connected account of the events subsequent to the third day after the first feed. It will suffice for our purpose to note that the whole of the epithelium is thrown off on the first feed, and that this desquamation takes place with remarkable rapidity.

We can see now how this will affect the parasites taken in with the food. In view of what I have said it will be seen at once that the conditions are by no means so simple as they appeared at first. Take the case of a parasite which has to become intracellular in order to complete its life history. If it happens to be in the middle of the mass of blood, and does not reach the epithelium till this is regenerating, it will have a chance to penetrate a growing cell and will find a safe place in which to develop, but if it happens to be near the gut wall it may penetrate a cell which is subsequently thrown off, and will fail to find its proper environment. Or in the case of a parasite which has to penetrate the wall of the gut to undergo the necessary changes, it may be able to penetrate at a point where the gut wall is thinned out by the desquamation but might fail if it reached a point where the cells are still columnar. A quite unlooked for element of chance is introduced by the desquamation of the epithelium, especially when we remember that it is necessary for the parasite to reach the gut wall quickly if it is to do so at all, for at a later stage of digestion the blood loses its fluidity, and moreover the parasite would be shut off by the layer of pigment, the result of the digestion of blood, which forms all round the epithelium, where the two are in contact.

There is another point to which I would like to refer, namely, the history of the parasite after it leaves the gut. We know that the ordinary mode of exit of

the parasite from the body and back to the vertebrate host is through the saliva, and that in order to reach the salivary glands it has to pass through the haematocoele. Here is another element of chance. So far as we know, the salivary gland tissue, and the ovaries, in the case of those parasites which are transmitted hereditarily, are the only tissues in which parasites can continue their existence and multiply, but it is quite certain that the parasites, once they penetrate the wall of the gut, will be distributed in the blood stream to all parts of the body. Little seems to be known of the history of any parasites once they leave the gut and before they reach the glands, but it is a biological improbability that they should select and move actively towards any particular part of the body. Since only those which reach the proper place, more or less by accident, can be passed to the vertebrate host, the chances are not very great, and can only be compensated for by an excess in the number of the individuals which start from the gut.

I think that what I have said is enough to indicate that, in the study of the environment of the parasite, whether it be a flagellate or a non-motile organism, and particularly of the processes of digestion in the blood-sucking flies, we have every hope of determining the unknown factor which should account both for the small percentage of success in transmission experiments, and for the relatively small percentage of *Anopheles* mosquitos which are found to harbour the parasite in places in which almost every human being is infected. I do not suppose that the suggestions I have put forward will account for more than a fraction of the missing factor, for our knowledge of insect physiology is a mere fragment of the truth ; if what I have said however will provide a working hypothesis, that will be sufficient for the present.

Progress report on Kala Azar.

A progress report on Kala Azar by Captain F. P. Mackie, I.M.S., which will be found in the appendix was then read. The following is a summary.

The laboratory work detailed below has been carried out in the Burdwan district during the last two and a half months. Of several thousand out-patients passed in review, most of whom suffered from enlarged spleens, 58 cases were found to be clinically suggestive of Kala Azar, and of these 23 (39·6 per cent.) shewed the presence of Leishmania on spleen puncture. The general type of disease in Burdwan was milder than in Madras. The diagnosis between chronic malaria and Kala Azar is very difficult, apart from the finding of the specific parasite, and, except in cases carefully observed in hospital, must be regarded with suspicion. No evidence was obtained pointing to any special seasonal occurrence or to house infection. The presence of Leishmania in the peripheral blood is unusual. Three hundred and twenty-one bugs caught in the beds of patients known to be suffering from Kala Azar were dissected. None were found to contain Leishmania. Seventy young bugs bred in the laboratory were fed on a case who had peripheral parasites, but no infection of these insects could be traced.

As a result of animal inoculation the following experiments were successful :—

White mice.—One positive out of twelve. Leishmania were found in small numbers in the spleen but none in the other organs. Sub-inoculation in the white rat was negative.

White rat.—Seven in number were all negative.

Flying foxes.—Two were inoculated and in one Leishmania were found locally three weeks later. The second animal suffered from an early general Leishmania infection, and these parasites were found in the pancreas and kidney but not in the spleen, bone marrow or other organs.

Monkeys.—One out of two monkeys became infected a month after inoculation. The spleen and liver were found to be infected but not the bone marrow and other organs.

The following experiments are proceeding :—

(1) The question of Leishmania infection of ankylostome worms,

(2) and of leeches.

(3) Attempted transmission of Kala Azar to a monkey by feeding it with water fouled with the fæces of a Kala-Azar patient.

(4) Transmission of Kala Azar to animals by the peritoneal route, by feeding and by skin scarification.

(5) The examination of dogs and other possible reservoirs of Kala Azar in endemic areas.

(6) The collection of biting insects in the endemic areas.

Dr. V. T. Korke introduced his paper on Kala Azar, of which the following is a summary.

Kala Azar.

Dr. Korke said that as a result of his epidemiological enquiries in Madras, he arrived at the following conclusions. That Kala Azar is endemic in Madras and does not manifest itself by epidemic outbursts as in Assam. It appears to be especially prevalent among Eurasians, less frequently among Hindus and least frequently among Muhammadans. Dr. Korke believes that Kala Azar is not a house infection in the sense that the disease clings to the actual building, but thinks that it is necessary that contact with a previous case should take place to effect transmission of the disease. This he supports by evidence showing that the disease tends to cling to communities having close social intercourse and to spread among the separate families forming such communities. The evidence collected by Dr. Korke appears to favour equally the insect-transmission and oral transmission theories and more work is clearly needed.

Captain T. C. McCombie Young next introduced his paper, giving an account of an investigation of endemic Kala Azar in the plains districts of Assam, of which the following is a summary.

Endemic Kala Azar.

The paper gives a short account of an investigation now in progress, which aims at obtaining precise knowledge of the extent to which Kala Azar in its endemic form is prevalent in Assam. A short account of the history of the epidemic of the eighties and nineties is given, and the authority of Major Leonard Rogers is quoted to emphasize the importance of protecting from infection the Upper Assam Valley in which the endemic form of the disease is still unknown, and to affirm the need for vigilance with regard to the future behaviour of the disease. Some suspicious tendencies towards increased activity of the disease in areas in which it is known to be endemic are described, and a short account is given as to what is at present known regarding the extent of the infection in these endemic *foci*. In reviewing the situation, the opinion is expressed that while the condition of affairs is not such that any immediate recrudescence of the disease in its epidemic form need be anticipated, yet there is need for vigilance, and the present period of quiescence should be utilised in preparations against a day when more serious conditions might arise. As the first step towards framing preventive measures, it appears necessary to ascertain the extent to which the health of the province is tainted with Leishmania infection and a scheme to effect this was drawn up. This scheme, which was approved by the local administration and which is now in active progress, is summarised as follows :—Fourteen sub-assistant surgeons and two assistant surgeons have been set to work in the affected districts. They will visit every village in the area allotted to them and ascertain the presence or absence of Kala Azar in each. Their reports will be checked and verified by the Deputy Sanitary Commissioner who is in charge of the investigation. On the termination of the survey it is hoped that precise information as to the number and situation of all the infected villages in the province will be available. When this is known, it is hoped that practical preventive and ameliorative measures can be put into operation and that further research into the causation of the disease will thereby be facilitated. The scheme is put forward with the object of eliciting constructive criticism and advice as to the conduction of the investigation.

Rai Kailas Chandra Bose Bahadur next read a paper on the relation of Malaria Fever to Kala Azar, of which the following is a summary.

Kala Azar and Malarial Fever.

The scope of the paper, which is based principally upon the reports of a few cases of fever closely watched from the very commencement of the illness, is simply to establish the fact that Kala Azar is only a phase of malarial fever and the results hitherto obtained from the Research Laboratories do not create grounds for its isolation. The benefit derived from prolonged investigation does not repay the time and labour spent upon it.

The Discussion.

Dr. Bentley said.—I wish to criticise some of the points raised in Colonel Donovan's paper. Colonel Donovan says he strongly suspects that the epidemics of Kala Azar reported from Assam were really malarial in origin. In answer to this I would like to recall to his memory the fact that long before the discovery of *Leishmania Donovani*, I reopened the discussion regarding the etiology of Kala Azar which had been declared to be malaria, because evidence, collected during the study of a serious epidemic of the disease, negatived this theory of causation, and after Colonel Donovan's discovery of the parasite in Madras, I obtained similar parasites by splenic puncture in a number of cases, many of whom had been under my observation for months. The epidemic to which I allude occurred on a tea garden in the Darrang district of Assam. Two coolie lines, containing a total population of about 1,200 people were invaded and of this population 900 eventually died. Altogether about 90 per cent. of those attacked finally succumbed to the disease. This epidemic resembles those previously described by Rogers as occurring on tea-gardens and among villages in other parts of Lower Assam. An important point in connection with this epidemic, to which I called attention in 1902, was the fact that new cases of infection usually appeared to occur in a household containing a case of the disease, only after the patient had developed dysenteric symptoms. I agree with Captain Mackie that there appear to be certain differences between the cases of Kala Azar in Assam and Bengal and those met with in Madras. It is almost impossible to find parasites in the peripheral blood of cases in the former areas. The spleen of these cases also is usually very hard and tough and there is little or no danger in performing splenic puncture with ordinary precautions.

Major Fry said.—Major Forster worked at malaria in Bengal during the cold weather of 1909. In his report he stated that Kala Azar was sufficiently prevalent to throw grave doubt on the value of a spleen census as a measure of malaria. In my recent report I have been at some pains to prove that he has over-estimated the amount of Kala Azar. My belief is that the amount of splenomegaly due to Kala Azar is less than 5 per cent. of the total, the remainder being malarial, and I am glad to find that Captain Mackie agrees with me. It seems quite certain that the disease as it exists in Bengal differs from the Madras type and is much less fatal. I have watched the natural recovery of two advanced cases. Two years ago these two boys were in the advanced stage with enormous spleens and livers, extreme wasting and œdema. They are now practically well. In the cases treated in hospitals dysenteric symptoms are uncommon. Again, the parasite cannot be found in the peripheral blood. I have examined blood from 23 proved cases and over 100 clinically diagnosed cases, examining 150 white cells in each and have not yet seen a parasite. I know western Bengal very well now, and Kala Azar is, at present, chiefly in the Purnea district.

Captain W. C. Ross suggested the possibility of the infection being water borne—either directly or indirectly through an intermediate host. The peculiar geographical distribution of the disease which is more prevalent in water-logged areas where the water-supply is contaminated and bad, and the fact that the opatimum temperature of development of the parasite is low and has a narrow range, and is practically the temperature of surface waters in the tropics during the greater part of the year, all point to the possibility of such a theory. No theory of transmission has yet been sufficiently investigated or proved and other possible means of infection than biting insects deserve attention.

Major Lalor said.—With reference to Captain Patton's admirable address on Kala Azar and in connection with my theory of the vicarious action, under certain conditions, of malarial carriers which I enunciated at this Meeting, the day before

yesterday, I raised the point of varying relation between parasites and their insect hosts. I do not wish to travel outside malaria which was the field of my remarks, but if I am to make my view plainer and put it tentatively into the form of a law, I would say,—the vitality of a parasite through its life stages in an insect host is the result of an asymbiotic relation between the individual parasite and the individual host, the terms of which are those of their relative vital potential. If the relative vital potential of the parasite is too high, the host dies, if the relative vital potential of the host is too high the parasite is destroyed. I was concerned at the time with the fact—if it is a fact—and not with its explanation.

Rai Kailas Chandra Bose Bahadur remarked that his difficulty arose from his inability to understand why a gulf should exist between the diseases of malaria and Kala Azar. He believed that the day would come when this gulf would be bridged and the diseases be shown to be identical. He was sorry to find that there is no record of any single case which has been watched from beginning to end. The disease must be known by its onset course and termination. The discovery of *Donovan* bodies in the blood of patients suffering from Delhi boil and Oriental sore compromises the value of the test to a material extent.

Investigation of Protozoal Diseases.

Captain F. P. Mackie then read a paper on the investigation of protozoal diseases with special reference to the differentiation of trypanosomes. The following is a summary.

The paper dealt with a scheme for the investigation of certain tropical diseases and was drawn up on the lines of the work of the Royal Society's Sleeping Sickness Commission in Uganda under Surgeon-General Sir David Bruce. It suggested a method by which such problems should be approached and indicated that work should be directed to four main points:—Firstly.—The microscopical examination and careful measurement of the parasite under consideration. Secondly.—Its effect on various laboratory or domestic animals. Thirdly.—The insect or other agency responsible for its transmission. Fourthly.—The question of the existence of a reservoir of infection in apparently healthy animals. Besides these, four other tests of a more technical nature were referred to. The methods employed in investigating a protozoal disease were then examined in detail and Captain Mackie took as a test the work on trypanosome diseases of animals done by the Commission in Uganda of which he was a member. Emphasis was laid on the existence of a "reservoir" of infection in apparently healthy animals, by which means a protozoal disease might be transmitted to new arrivals in a district, through the intermediary of the appropriate insect carrier. As an instance of this, the Commission's findings of the evil potentialities of the wild game in Uganda as reserve supplies of the virus of Sleeping Sickness were referred to, for certain antelopes which are apparently perfectly healthy are infected with human trypanosomes and tse-tse flies act as a "go between" from these animals to man. In conclusion, three postulates were laid down in determining the part played by an insect as a carrier of a specific infection. These were:—(1) The parasite should be found in the insect in its wild state and the distribution of the disease and of the carrier should coincide, remembering that the intermediate host may exist without the disease, but where the disease is spreading, the insect carrier must be present. (2) The parasite should be shewn to be capable of living, developing and perhaps passing through certain stages of its life history in the body of "laboratory bred" specimens of the suspected carrier which have been fed on infected material. (This eliminates the confusion liable to be caused by the presence of natural parasites in the insect. Hereditary transmission of these must be excluded.) (3) The disease should be transmissible from a diseased to a healthy susceptible animal by the intermediary of laboratory bred insects of the appropriate species. The speaker concluded by applying these postulates to well known tropical diseases. He pointed out that the role of the mosquito in malaria, the tse-tse fly in sleeping sickness, the rat flea in plague, the Tick in African relapsing fever, and the body louse in Indian relapsing fever, satisfied all these postulates whereas in the case of the *Stegomyia* mosquito in Yellow Fever (which was certainly the true carrier), and the body louse in typhus fever, only one postulate was at present satisfied whilst in the "bed bug theory" of Kala Azar only the second and least important postulate was as yet proved.

The body louse as a disease carrier.

Captain F. P. Mackie finally introduced his paper on the body louse as a disease carrier: the following is a summary.

The author states that since his original observations in 1907, on the part played by the body louse in an epidemic of relapsing fever in the Mission School at Nasik, a good deal of evidence has been produced to substantiate the hypothesis, and the disease carrying powers of the louse in other directions has been subjected to critical examination. He first outlined the conclusions to which he originally came when working at Nasik, and as a result of the analysis of the work, since published, he maintains the position that the body louse is the true insect carrier or intermediate host of the parasite of relapsing fever ("*Spirochæta Carteri*"). From observations in St. Petersburg, in Morocco, in Egypt, in Paris and elsewhere, these results have been confirmed. In all places where epidemics have been examined in the light of the Nasik observations, the epidemiological evidence has been strongly in favour of the louse, and generally as strongly against the bed bug hypothesis of the transmission of relapsing fever, which previously held the field. Sergent and Foley in Morocco have succeeded in transmitting the disease from men to monkeys, with regularity, through the medium of the louse, and Mantefel in Germany has shown that relapsing fever in rats is readily carried from one animal to another by the rat louse. The three postulates necessary to incriminate an insect as a true intermediate host have therefore all been satisfied, (1) that the insect in its wild state harboured the blood *Spirochæte*, and this was coincident with the distribution of the disease. (2) That the *Spirochæte* was found to be capable of living and multiplying in lice fed artificially on patients suffering from relapsing fever. (3) Whilst the third and most important postulate was proved by Sergent and Foley in North Africa; they had succeeded in producing relapsing fever in monkeys on which infected lice had fed. The paper then describes some experiments, which have been done in Tunis by Nichole, and in America by Anderson and Goldberger and by Ricketts and Wilder, on the transmission of typhus fever by the body louse. The evidence is strong enough for one to state definitely that the body louse is also the carrier of typhus fever. The epidemiology of relapsing fever and typhus fever are almost identical; these diseases have existed side by side, often undifferentiated, from time immemorial. The virus of typhus fever has not yet been discovered, though that of relapsing fever has been recognised since 1875. The paper concludes with a summary of the main known fact concerning the appearance and habits of the body louse, and it is stated that, owing to the susceptibility of the louse to antiseptics, and even to plain washing and sun-drying, epidemics of relapsing fever and of typhus fever should be easy to control in the future.

RESOLUTIONS.

The following Resolutions were then placed before the Meeting and all were passed without dissent:—

1. That after another year's experience and investigation, this Meeting desires to endorse and again bring to notice the Resolutions passed at the last Meeting as noted below:—

(*i*) This Meeting is of opinion that researches by experts in the field, such as those carried out by Christophers and Bentley, prove the value of preliminary scientific investigation, and seem to point the probability that anti-mosquito measures may not prove so costly as was at one time feared.

(*ii*) The Meeting believes that no one measure can be suitable for all the conditions that favour the prevalence of malaria; that quinine prophylaxis applied to a free population is difficult to carry out in the thorough way necessary for success; and that a combination of several measures may be required as local circumstances may indicate. The Meeting is of opinion that notwithstanding the difficulties of quinine prophylaxis, it cannot be too strongly emphasized that under the peculiar conditions of the Indian populace, arrangements for the treatment by quinine of

those sick from malaria is a matter of primary importance from the point of view of saving life, of preventing suffering, and of destroying a potent source of infection.

(*iii*) The Meeting desires to call the attention of Government to the possibility of danger arising from borrow pits in proximity to human habitation, especially when such excavation would result in stagnation of water therein.

(*iv*) The Meeting is of opinion that the education of the people is a most important anti-malarial measure and that every effort should be made to secure the co-operation of the public, without which there is little hope that the campaign against malaria will ever be crowned with success. It is believed that instruction in schools, as well as lectures and lantern demonstrations in villages and towns, are the best methods of propagandism and that in this way, information is more likely to reach the people, than by the publication of pamphlets and posters.

(*v*) The Meeting, while strongly recommending the prosecution of further research, is of opinion that, although expert investigation is still necessary, enough is known as to the breeding habits of mosquitos, etc., to make it frequently possible, for trained workers, to deal with malaria in an efficient manner.

2. That in view of the correlation which certain observers have found to exist between density of jungle in and around villages on the one hand, and intensity of malaria on the other, it is desirable that this question should receive the careful attention of all those working at malaria in India, with a view to the collection of information for discussion at the next Meeting.

3. That experience, in the United Provinces and elsewhere, has shown that the regular administration of quinine to children in schools during the malarial season is a practical measure of proved utility and of easy application; and that this measure, in addition to its immediate effect on health, is likely to prove a powerful aid in the spread of knowledge regarding the uses of quinine, both in the prevention and cure of malaria.

4. That, amongst methods of combating malaria, this Meeting desires to lay special stress on general methods of water tidiness, such as the filling up or draining of pools in which dangerous mosquitos may breed, and the cleaning and trimming of the edges of all tanks or water courses situated in the proximity of villages, so as to deprive the mosquito larvæ of the protection against their natural enemies afforded by weeds; and that in rural areas this object can best be attained by the formation of anti-malarial societies on the lines of the Coronation Anti-Malarial Society recently started at Jessore.

5. In view of the fact that investigation has shown that the cultivation of rice and other crops for which an abundance of water is necessary during growth, need not lead to the formation of dangerous breeding grounds for mosquitos, it is desirable, in the interests of agriculture in India, to definitely ascertain the precise conditions under which such cultivation is, or is not, likely to be harmful.

6. That the provision of a pure and protected water-supply and any means, whereby the health of a population can be improved and its power of resistance to disease increased, must be regarded as important measures of sanitation, useful alike against malaria and other diseases both in urban and in rural areas.

7. That further research is necessary with a view to ascertaining the most effective larvicides and natural enemies of the mosquito, and which of them are best suited for use in particular localities and under different conditions of environment. Also that it is desirable to consider the advisability of constructing ponds in centres where permanent water can be obtained, for the breeding on a large scale and the distribution of the more important of the natural enemies of mosquito larvæ.

8. That, pending the completion of the *Stegomyia* surveys, this Meeting is not in a position to express any opinion as regards the practicability of the extermination of this mosquito or its reduction to non-dangerous numbers in our chief ports.

9. That further enquiries are necessary into the etiology and modes of transmission of the various forms of *Spirochætal* infection and of the fevers of short duration such as Dengue, "Seven Day" and "Three Day" fevers, the pathogenic organisms of which appear to be closely allied to that of Yellow Fever.

10. That, whilst continuing the examination of dogs and the laboratory experiments in connexion with the etiology and modes of transmission of Kala Azar, further field investigations should be undertaken both in Madras, Bengal and Assam with a view to ascertaining what are the conditions specially favourable for the spread of the disease.

PRESIDENT'S CLOSING REMARKS.

Surgeon-General Sir Pardey Lukis in closing the session said :—

I wish to thank you all for the attention you have paid to the discussions, and also for the many excellent papers that have been put before us. I think we have had three extremely interesting and instructive days, and Sir Harold Stuart has asked me to say how very much impressed he has been by the great growth of interest and the enormous expansion of research and other work that has taken place since he presided over our first Meeting at Simla in 1909. Each year there has been a steady improvement both in the papers read before the Meeting and in the subsequent discussions, and I hope that next year we shall do better even than this year. In conclusion I wish particularly to associate myself with all that Sir Harcourt Butler said in closing the Sanitary Conference as regards our gratitude to the Madras Government, and every one concerned, for all they have done, both to entertain us personally, and to make this Meeting a success. I am sure you will all join with me in this expression of our gratitude, and particularly in according a cordial vote of thanks to Major Robertson, Captain Justice and Captain McKendrick who have been the moving spirits and the working officers of the Meeting.

APPENDIX

TO

PROCEEDINGS

OF THE

THIRD MEETING

OF THE

GENERAL MALARIA COMMITTEE.

REPORT ON THE WORK OF THE CENTRAL MALARIA BUREAU, 1911-12.

A complete set of all the known Indian anopheles having now been obtained, the work of the Central Malaria Bureau has consisted, first, in making as many duplicate sets, as possible, of the type specimens, to enable officers, working at the Bureau, to take out and thoroughly examine specimens without there being any danger of the type ones being injured or destroyed ; secondly, in making up and sending to public Institutions and Colleges, both in India and abroad, complete sets of Indian anopheles or as nearly complete sets as it is possible to obtain within a reasonable time; thirdly in collecting a very large number of as many varieties as possible for the use of officers and warrant officers at the malarial class, held twice a year, as well as the bacteriological class held every second month, at which two or three days are always devoted to malaria. In addition, the identification of the large number of anopheles or culicines, sent to the Bureau for that purpose, has been continued, though the work has been somewhat delayed owing to the medical officers in charge of the Bureau having been away on special duty in the Andamans, Amritsar and Delhi.

A point was made this year of collecting and identifying varieties of fish which are known larvæ feeders throughout their lives. Specimens of the following were added to the collection at the Bureau :--

Haplochilus panchax.

Haplochilus lineatus.

Basbora daniconius.

Ambasis Ranga.

Anabas scandens.

Ophiocephalus punctata.

Danio Cyprinidae

as well as the following specimens of the duckweed tribe,

Lema Minor and *Gibba*,

Woolfia and *Asolla*

which have been found, when growing in a thick layer on the surface of pools, to be a hindrance to the growth of larvæ.

During the year a note was made of the various stations from which specimens of some of the commoner known carriers of malaria were received. *Myz. Culicifacies* was received from the following :—

Amritsar	Punjab.	Abbottabad (3,900 ft.) ...	Frontier Province.
Delhi		Tall	
Atari		Tonk	
Ferozepore		Quetta	Baluchistan.
Kalka		Kacha (5,000 ft.) ...	
Balaghat	Central Prvinoces.	Bombay.	
		Jeypore.	

N. Stephensi from—

Amritsar	Punjab.	Abbottabad ...	North West Frontier Province.
Delhi		Tall	
Rawalpindi ...		Tonk	
Beas		Poona	Three stations in the Central Provinces.
Madhopur		Bombay	
Multan			

Hy. Fuliginosus from :—

Amritsar	Punjab.	Abbottabad in North West Frontier Province.	
Delhi			
Rawalpindi ...		Agra in United Provinces.	
Kangra			
Tharrawaddy in Burma.		Mandla	Central Provinces. Sibsagar.
		Rewah	Jalpaiguri.
		Balaghat	Jeypore.
		Hoshangabad ...	Bombay.
		Hodel	

These lists only show stations from which specimens have been received, for identification, at the Bureau, yet are sufficient to indicate how widely disseminated are these three common carriers of malaria.

MALARIA IN THE MADRAS PRESIDENCY.

NOTES ON THE STATISTICS OF THE PAST 10 YEARS.

By Captain J. H. HORNE, I.M.S., Special Malaria Officer, Madras.

In accordance with the original scheme of the Madras Malaria Board, a preliminary inquiry into the vital statistics of the Presidency was commenced on August 16, 1912, and though still far from complete, has revealed points of interest which are perhaps worthy of record now.

The revenue taluq (*i.e.*, the sub-division of a district) has been taken as a unit, a variable one it is true but averaging roughly 600 square miles and containing 200,000 persons. The total mortality figures of these taluqs have been "graphed" and examined as to seasonal swings and epidemic rises, and associated natural conditions studied.

The Madras Presidency, thanks to its remarkable variety of physical features and climate, may well be divided into five natural divisions *viz.*,

1. West Coast Division
2. South ,,
3. East Coast (proper) ,,
4. Deccan ,,
5. The Agencies or Hill Tracts in the north-west of the Presidency;

and the interest of the present incomplete inquiry may best be attained by choosing five districts representative of these divisions and examining each in turn.

I.—WEST COAST DIVISION.

District—S. Canara.

An abundant rainfall and rich soil render this district one of the most fertile in the Presidency. The annual rainfall averages 145 inches and occurs mainly from June to September. The climate is moist but equable.

Mean Temperature	...	...	= 76 (January) — 83 (May)
,, Humidity	...	...	= 77 — 80 per cent.

Rice is grown in the valleys, millet on the hill sides, while the higher slopes are covered with dense forest.

The vital statistics show a fairly high birth rate, death rate and infantile mortality, the average of the past five years being 35 and 28 per mille and 19 per cent. respectively. With the exception of the year 1907 these vary little.

The mortality curve shows remarkably regular seasonal variations. There are two main annual rises; one from June to September, coincident with the south-west monsoon; the other from December to February. The latter is almost always the higher and reaches an epidemic figure of 2-3.

S. Canara has the reputation of possessing a high "fever" death rate and the regularity and shape of the December rise certainly suggest malaria, though this will require further investigation.

The cause of the high mortality in 1907 was a double epidemic of cholera in July and December.

II.—SOUTH DIVISION.

District—Tinnevelly.

A flat surface and an equable hot climate are the main characteristics of this, the most southerly district in the Presidency.

The rainfall is scanty, averaging only 27·35 inches and occurs mainly from October to December.

Mean Annual Temperature	...	...	85·4° (77°—86°)
„ Humidity	...	...	65 per cent.

The northern half of the district consists of black loam and is little irrigated the southern half on the contrary has a red sandy soil and is both irrigated and extensively cultivated, rice being the chief crop.

The statistics show a moderately high birth rate and low death rate, though a rather high infantile mortality.

Birth rate	...	...	34·3 per mille.
Death rate	...	...	26·2 „ „
Infantile mortality		...	18·8 per cent.

The *total mortality curves* are always highest during the rainy months (October—December) sometimes reaching an epidemic figure of 3; but cholera is then present and is apparently the cause though the curves are not typical. The southern taluqs do not appear to be more affected than the northern. An unusually high death rate in 1906 was also due to this disease.

An epidemic of malaria is said to have occurred in a small part of the Nanguneri (southern) taluq in February and March of this year (1912). The taluq curve shows no evidence of this and a detailed report is not as yet available.

III.—East Coast Division.

District—Chingleput.

This is a fertile low lying district with a moderate rainfall and temperate climate. The rainfall averages 45 inches and occurs mainly from October—December.

Mean Annual Temperature	...	...	82° (76° — 88°)
„ Humidity	...	...	71 per cent.

The soil, apart from a wide sandy strip along the coast thickly planted with casuarina trees, is well adapted for cultivation, and is irrigated by means of large artificial tanks throughout the country. Rice and ragi are the main crops.

This district is known to contain centres of hyperendemic malaria, confined so far as is known, to the sandy strip along the coast.

Vital statistics show a high birth rate, (the highest of the five districts under consideration) a moderate death rate and a high infantile mortality.

Birth rate	...	...	35·8 per mille.
Death rate	...	...	24·2 „ „
Infantile mortality		...	21 per cent.

Here again the mortality charts show a rise at the end of the year, commencing in September and falling in February. The extent of this rise is much greater in some taluqs than in others. In Tiruvallur and Saidapet the deaths are almost twice as numerous in the wet weather; in Ponneri and Chingleput (which curiously enough are both coast taluqs) the rise is very slight.

No reason for this can as yet be given.

There are no signs of epidemic malaria. The years 1901 and 1906, were exceptional in having low birth rates. That of 1906 is explained by a severe cholera epidemic in the previous year; in 1901 the cause is unknown owing to the want of statistics.

IV.—DECCAN.

District—Cuddappah.

Generally speaking, Cuddappah is a dry upland district, more barren than fertile and with a scanty rainfall. The latter averages 28 inches annually and occurs mainly from July to September. The climate is drier and presents greater degrees of heat and cold than the coast districts.

Annual Mean Temperature ... ... 84°

„ Humidity ... ... between 60 and 70 per cent.

The country is very liable to floods, the cultivation is mostly "dry", and the chief crop is cholam.

A somewhat more detailed description of the taluqs is necessary, owing to the occurrence of localised malaria epidemics in them.

(1) The four south-west taluqs form part of the Mysore table-land and lie at an elevation of 1,500-2,000 feet. The surface is hilly, the soil poor and the crops "dry". The climate is said to be healthy.

(2) The four northern taluqs are lower lying, flat and consist of black cotton soil. The crops here also are "dry". These taluqs include Cuddappah, notorious for "fever".

(3) The three eastern taluqs are also low and flat, and contain large belts of alluvium which make them the most fertile in the district. The crops here are mostly "wet".

The vital statistics show a low birth rate, death rate, and infantile mortality.

Birth rate ... ... 26·7 per mille.

Death rate ... ... 22·5 „ „

Infantile mortality ... ... 15·16 per cent.

The total mortality charts keep, as a rule, remarkably steady and show ittle tendency to the cold weather rise so noticeable in the other districts.

In the years 1910 and 1911, however, vital statistics and mortality curves underwent a marked change, owing to the occurrence of two epidemics, which the evidence so far obtained goes to show were malaria.

The figures for the district are as follows:—

Average.	1905-09.	1910.	1911.
Birth rate	26·7	21·3	21
Death rate	22·5	32·7	24·5
Infantile mortality	159·7	232·9	155·5

The 1909-10 epidemic, the more severe of the two, involved five taluqs in the south-east corner of the district, with its centre at Royachuti (a hill taluq) whose epidemic figure was 5·9 and spread to a slight extent eastwards to the adjoining district of Nellore. It commenced simultaneously in all five taluqs in October, reached its height in December and ceased in the following March.

Both the south-west hill and east alluvial taluqs were affected; the northern, with the exception of Cuddapah, not at all.

The 1910-11 epidemic was also localised but affected the northern taluqs mainly, with its centre at Cuddapah (E.F. = 4·3). This time the hill taluqs with one exception escaped.

In both epidemics almost all the taluqs affected showed an abnormally heavy rainfall that year.

The deaths were mainly among children; in Royachuti taluq in December 1909 and January 1910, the death rate among children from 1-10 years was thirty times the normal, that among adults in each decennium (from 20-50) thrice.

Still more significant is the effect of these epidemics on the birth rate of the following year.

	Births.		
	Average, 1905-09.	1910.	1911.
Vayalpadi (involved 1909-10)	3,366	1,812	3,318
Cuddapah (involved both years)	3,266	2,354	2,326
Siddhout (involved both years)	1,804	1,337	1,428

Cholera was not prevalent in the district during these epidemics. In one taluq it did occur in December 1910, and it is interesting to note that the age mortality was then greatest among adults.

V.—Hill Tracts.

District—Vizagapatam.

From its history and physical features, its pleasant climate and yet unhealthy reputation, this district is perhaps the most interesting in the Presidency.

It has long been known as a malarious region. As far back as 1859 an attempt was made to build a Sanatorium for troops on one of the hill ranges, and of 50 or so soldiers sent up all but two got fever and the project was speedily abandoned.

The district consists of two main parts—

(1) A flat strip of red soil, 30 miles broad, along the coast.

(2) A hilly plateau 1,000—3,000 feet high, to the west of this.

In the flat the rainfall averages 41 inches and occurs mainly in September and October.

Mean Annual Temperature	81°
„ „ Humidity...	72·6 per cent.

In the hills, the annual rainfall is 57 inches, as they receive the south-west monsoon in addition, and the climate is naturally cooler.

The vital statistics show rather a low birth rate but are otherwise normal.

Birth rate	28·7 per mille.
Death rate	23·8 „ „
Infantile mortality	15 per cent.

As regards the total mortality charts, Golgonda, (the only hill taluq for which returns are available) shows an annual rise in November and December, of varying height, sometimes giving an epidemic figure of from 2-3. This taluq is notorious for malaria and the chart appears to bear this out, but further investigation is necessary.

Of the taluqs in the flat some also show this rise at the end of the year, but to a less extent; others (*e.g.*, Vizagapatam) keep remarkably level.

SUMMARY.

1. Only one district shows evidence of epidemic malaria: its soil is barren its climate dry, its rainfall scanty but when heavy liable to cause floods.

The epidemics were localised and associated with increased rainfall but not with drought in the previous year.

The epidemics were followed by a marked reduction in the birth rate of the subsequent year.

2. Normally, deaths are most frequent at the beginning and end of the year. This rise is accentuated in districts known to be malarious.

3. Areas known to harbour endemic malaria appear to be associated with a high infantile mortality, but may possess a high birth rate.

RESULTS OF THE MALARIA INVESTIGATION IN THE CENTRAL PROVINCES.

By Major T. G. N. Stokes, I.M.S., Sanitary Commissioner, Central Provinces.

The investigation has now been in progress for two cold weathers, *viz.*, 1910-11 and 1911-12, and has completed the inquiry on the lines laid down in Paludism No. 2, for 10 out of 22 districts. It is now decided to expedite the completion of the remaining districts by working continuously all the year round instead of confining it to fever seasons, which has hitherto been the method. A separate report has been issued on the work for each season, but I may here summarise briefly our results.

Endemic malaria.—This, as might be expected from the climate and physiography of the country, is widely prevalent, more particularly so along the Satpura hills which run right across the province. The following are the causes assigned for this state of things :—

1. The presence of scrub jungle, dense jungle and rank vegetation in the vicinity of villages.

2. The presence of harmful species of anophelines, *viz.*, *M. Culicifacies*, *M. Listoni*, *N. Theobaldi*, and *P. Jeyporensis*, all of which breed in shady jungle ravines with hard stony impervious beds, which retain water to the end of the cold weather.

3. Low economic condition of the people.—This reaches its maximum in the rains when their grain supply—*kodon*, *kutki*—is getting low, there is no jungle product with which to eke it out and no money to be earned outside—they are moreover poorly clothed and mosquitoes abound.

4. Social conditions.—Jungle villages are frequently split up into groups of huts at short distances apart, which make village site-clearing difficult ; there is moreover the system (jagal) of watching crops round the jungle edge to frighten away pig, peafowl, etc., which exposes the villager at night to the onslaught of mosquitoes.

The effect on the population of endemic malaria is to increase the death rate by about 10 per mille per annum. The birth rate remains practically the same as that for healthy villages, but the seasonal variation is quite different, the highest rates being recorded early in the year instead of in the autumn, which is the rule in healthy tracts. This is accounted for by the fact that during the fever season (December-March) conception is relatively rare.

The villages of the Vindhyan range of hills in the north (Saugor) of the province are not hyperendemic, though their physiography may closely resemble that of the Satpuras. The people of the Vindhyan hills are agricultural, they clear their village sites, and have different social customs. Harmful anophelines are few—whether this depends upon the site clearing or upon the fact that the geology and flora of the two ranges are different has not yet been explained.

Epidemic malaria.—Nothing of the nature of what occured in the Punjab and United Provinces epidemic in 1908, has been found in the Central Provinces, but there were recent minor epidemics in 1902, 1908, 1910, the last being closely associated with rainfall. The epidemic in 1908 was confined to the northern districts and was part of the severe outbreak experienced in other provinces. The results of our investigations tend to show that scarcity and high subsoil water are not essential to epidemic outbreaks, nor are the latter dependent on malarial endemicity. The child mortality and subsequent fall in the birth rate are particularly noticeable. The maps, statistics, details of anophelines, etc., are all given in the two reports published.

Black water fever.—A case of death from this condition occurred in the Balaghat district on the 26th January 1912. The patient was a European aged 34 years who had suffered previously from malaria. The Civil Surgeon informs me that he had all the typical symptoms of the condition which cleared up on the 3rd day but a relapse occurred, rigor, temperature of 103·4°-F., dark

urine, etc., with fatal result after an illness of six days. Quinine was not used. Another death of a European occurred in the Drug district in a case where malignant tertian infection was previously known to exist. The symptoms were typical of Black water fever, except that the urine was not characteristic. The illness lasted from the 8th to the 16th April with profound jaundice, albuminuria and pyrexia. Bile was passed in the stools up to the end, and the blood examination was negative as to malaria or evidence of suppurative conditions. Quinine was given intramuscularly, and the temperature was normal next morning (15th) but rose again followed by hiccough, coma and death. The Civil Surgeon thinks the case was one of malignant malaria with sporulation in the internal organs. It would be interesting to know if cases of this kind have been met with elsewhere.

A NEW CONCEPTION REGARDING MALARIA.

By Dr. C. A. Bentley, M.B., D.P.H., Special Deputy Sanitary Commissioner, Bengal.

The suggestions that have been made from time to time that our knowledge of malaria is now so complete that it can be reduced to mathematical formulae and its problems solved by algebraic equations, point to the danger of research becoming stereotyped.

Already if we may judge by many recent text books and reports, the current idea regarding the investigation of malaria appears to be that it consists essentially in a routine of blood examination, spleen counting, the capture, indentification and dissection of anopheles, and the mapping out of the breeding places of these mosquitoes

But although the brilliant discoveries of Laveran and Ross have extended our knowledge of the parasitology of malaria so far that there appears to be little room for advance in that direction, we are still ignorant of many of the factors responsible for the occurrence of malarial disease, more especially when it appears in epidemic form among populations like those to be met with in India ; and there are reasons for believing that until our conception of infectious diseases in general and malaria in particular undergoes a radical change, these gaps in our knowledge may not only remain unfilled but actually pass unrecognized.

But before proceeding to outline a new and possibly somewhat startling conception regarding disease, based upon the facts that have been ascertained regarding parasitology in general, and largely those especially relating to malaria, it is necessary to point to certain current fallacies regarding the latter condition which appear to have long escaped recognition, perhaps because of their very magnitude.

In the first place attention must be called to the fact that ever since Laveran's discovery of the malaria parasite, medical men have failed to distinguish between *malarial infection* and *malarial disease.* This want of discrimination has given rise to much confusion in the past and in recent years has led to some heated disputes between those who asserted that there must always be a direct relation between the amount of malaria among a population and the number of anopheles capable of carrying infection, and those who pointed to observations in which it was impossible to trace such a direct connexion.

There is a wide divergence to be observed between the phenomena of infection and disease, and as regards malaria not only do we possess no evidence to show that morbidity and mortality bears a fixed relation to the occurrence of infection, but many observations in all parts of the world support the view that, under some conditions at least, the amount of malarial disease present in a community may vary inversely with the amount of infection present.

Years ago Kock, Stephens and Christophers, and others showed that among children of races indigenous to Africa and New Guinea, the occurrence of almost universal infection with malaria parasites, was associated with little or no evidence of disease; and more recently workers in India have pointed out that the infection index of a population may remain almost stationary although at one time disease might be prevalent and another time almost absent.

Unfortunately the significance of these observations has been largely overlooked and the word "malaria" is almost invariably applied to describe both the condition of infection and the state of disease which may be associated with it; moreover "*malarial infection*" and "*malarial disease*" are constantly used as though they were synonymous terms. But the distinction is of more than academical importance. A hundred malaria infections in Negro children in West Africa represent a very different condition as regards sickness to that of a hundred infections in Europeans resident on that coast; and the morbidity associated with a 25% infection-rate among troops in barracks may be very different to that observable amongst them when engaged on arduous field service.

Again in the case of two communities A and B possessing respective infection rates ,of 10% and 100,%, it is highly probable that A may show a larger proportion of cases of malarial disease than B. Or if we represent the monthly infection rate of a community by a hypothetical curve and the morbidity rate by another, there is no certainty that the two will show any marked relation, except when we are dealing with non-immunes, in which case the curves of infection and disease will tend to be the same.

A consideration of these facts shows that although it may be possible to demonstrate a definite relation between the "static malaria" of a community and the number of anopheles capable of carrying malaria, it is not at present possible to show a similar relation between the number of anopheles and the amount of disease; and points to the necessity of clearly distinguishing between "*infection*" and "*disease*" whenever the investigation of malaria is undertaken.

The common practice of using as the basis for conclusions regarding malaria data obtained almost entirely from the study of the condition in non-immunes is also likely to give rise to erroneous ideas, especially regarding the problems to be faced in connexion with the disease among partially tolerant races.

At present the bulk of the facts recorded about malaria in current text-books and medical journals, relate to observations of infection (usually in cases of disease) among white immigrants to the tropics or those who have returned to Europe after residence in a malarious country.

But until it has been shown that the reactions between the parasite and its host in the case of non-immunes, are similar at least in kind if not in degree to those occurring in the case of partially tolerant races, living usually under very dissimilar conditions, the conclusions referred to cannot be accepted as final.

It is certain in view of what is known about the wide divergence in behaviour exhibited by such infections as measles in South Sea Islanders and Londoners respectively, trypanosomes infection in imported and among indigenous cattle and horses in South Africa, and phylloxera among European and American vines, this distinction between malarial infection in non-immunes and that in partially tolerant races becomes an important one. To emphasize this point an illustration may be drawn from physical science.

It is well known that we can ignite magnesium wire with a match and cause it to burn like a candle. We cannot do the same with iron wire. And when we see iron wire burning with as great an ease as magnesium wire, we may be quite certain that it has been exposed to something more than the mere application of a match. Among the members of a race non-immune to or non-tolerant of malaria, the mere introduction of infection is sufficient to provoke disease, and the magnitude of an epidemic will be largely if not entirely governed by the factors which influence infection. But the occurrence of epidemics of malarial disease among the usually tolerant or partially tolerant races, indigenous to malarious countries, signifies something beyond the mere presence of infection and anopheles; and it is just that "*something*" which requires to be investigated by malariologists in India.

There is yet a further point upon which current opinion regarding malaria does not appear to be in accord with fact. It is commonly assumed that the occurrence of malarial infection is an abnormal condition. But although malaria in a Londoner may be abnormal, the presence of the parasite in the blood of children in the West Coast of Africa is as normal a condition as flea infestation is to a dog.

In order that the significance of this fact may be properly grasped it is necessary to take a brief glance at parasitism in general. It is now recognized that parasitism and parasitic infestations are natural conditions both of the animal and vegetable world. Every species of animal harbours not one but many species of parasites; and man in common with other animals supports an extensive parasitic fauna and flora.

And though at one time it was supposed that parasitic infestations were almost invariably pathogenic, it is now recognized that organisms frequently

associated with the occurrence of disease, such as the bacillus of typhoid, diphtheria, the pneumo-coccus, meningo-coccus and staphyllo-coccus, may be harboured for long periods without producing unpleasant symptoms in their host.

Moreover in the case of primitive populations of tropical countries such as India, a large proportion of the people are found to harbour astonishing numbers of such ecto and endo-parasites as fleas, lice, bed-bugs, parasitic fungi, round-worm, whip-worm, thread worm and ankylostoma and a host of others, whose presence they tolerate with but little inconvenience.

Thus it has come about that the narrow view which looked upon parasites in general as malignant organisms always seeking to cause destruction, disease and death, has given place to the more philosophical conception, which regards them as lowly organisms, fitted by nature for a life in association with those of higher development; and infectious disease not so much as the result of more parasitic infestation but as an accident in the course of which the natural adjustment of a host to its parasites is upset.

As far as we know parasites do not give rise to disease of intent, and when a disease condition occurs, it is often as fatal to the parasite as to its host.

Parasites are as amenable to the ordinary laws of existence as other organisms. They are only found where conditions are suitable for them and they increase or decrease just as other animals or plants do, in proportion as their environment is favourable or unfavourable to them.

As regards the parasites of malaria, observations in all parts of the world have shown that they are to be found in the blood of man wherever conditions are favourable to their continued existence and spread, just as drepanidia occur in the blood of frogs, trypanosoma in the blood of rats and halteridia in the blood of birds.

And as it usually happens that the more primitive races of mankind live in countries and under such conditions as are specially suited to the existence of the malaria parasite, it has come about that a very close association is to be observed between primitive man and malaria; and usually the more primitive a race is, the larger the proportion which is infested with malaria parasites, and the more complete the tolerance which they exhibit to its presence.

From these observations it would appear reasonable to assume that infestation by the parasites of malaria is a natural condition of the life which a large proportion of the populations indigenous to malarious countries is accustomed to lead under circumstances which favour the continued existence of the organism; and that it is only to be looked upon as abnormal when it occurs apart from these conditions.

In these introductory paragraphs it has been pointed out that a distinction must be drawn between malarial disease and malarial infection; that environment may exert an extraordinary modifying influence upon parasitic infestations, including that of malaria; and that in common with many other parasitic organisms the malaria parasite frequently occurs as a perfectly natural associate of man.

It is now possible to outline a hypothesis concerning infective disease in general and malaria in particular which may prove suggestive in stimulating future research both as regards the origin of disease and the methods to be adopted for its prevention or control.

Attention has already been drawn to the fact that parasitism and parasitic infestation are universal rules of the animal world; and that among mankind, the more primitive the habit and mode of life of a race, the more certain it is to be infested with a multitude of parasites of all kinds. But like other animals, man becomes adjusted to his natural parasites and under ordinary circumstances suffers little or no inconvenience from their presence.

Lankester in his "Kingdom of man" states:—

"Natural selection and the survival of the fittest in the struggle of existence lead to the production of a degree of efficiency and harmonious interaction of the units of the living world, which being based on the inexorable destruction of

what is inadequate and inharmonious as soon as it appears, result in a smooth and orderly, working of the great machine, and the continuance by heredity of efficiency and a high degree of individual perfection.

Parasites, whether microscopic or of larger size, are not in such circumstances the cause of widespread disease or suffering. The weakly members of a species may be destroyed by parasites.....but the general community of the species, thus weeded, is benefited by the operation. In the natural world, the inhabitants of areas bounded by sea, mountain and river become adjusted to one another; and a balance is established."

In another passage he remarks :—

> "Not only does the human race within given areas become adjusted to a variety of local parasites, but it acquires a tolerance of dangerous drugs such as alcohol and opium, extracted by man's ingenuity from materials upon which he operates."

All animals therefore including man obey the rule that they must become adjusted to their environment; and if parasites form a part of that environment they must be included in the scheme of adjustment.

If we study mankind in relation to the world of parasites we may note that at one end of the scale is primitive man, tolerating a large assortment of parasites with impunity, and at the other end of the scale is the most highly civilized man, already comparatively free of parasites, and so highly intolerant of them that he suffers serious disease when brought into immediate relation with them.

Just above the savage in the scale are the races which having achieved a few steps towards civilization are content to pass from century to century in a condition of stagnation. They too like the savage support an extensive parasitic fauna and flora and like him enjoy a comparative immunity under ordinary conditions from unpleasant symptoms, owing to their more or less complete tolerance of their parasites. Until comparative recent times the bulk of the population of India may be said to have been in this condition.

It has already been pointed out that highly civilized man has largely freed himself from parasites; and it would appear that civilization is largely incompatible with a condition of continued parasitic infestation. This comparative freedom from parasites enjoyed by civilized man has been brought about by the same process of evolution which has stimulated his advance in other directions. The gradual intensification of the struggle for existence between the individual members of a race or species produces a rapid development and at the same time results in the elimination of the most inefficient. The presence of parasites is a handicap, and a cause of inefficiency; they consume energy which might otherwise be usefully expended in work and they lessen the powers of adaption of the host to his environment; and other things being equal a parasite free individual or race will always triumph over a parasite ridden one. Regarded purely as a machine turning fuel into energy the civilized man compares favourably with his primitive brother; and the result is that the work he can accomplish is incomparably greater. This is in part due to the fact that as he has advanced along the path of civilization he has discarded his parasites along with other useless burdens.

In that remarkable book "The martyrdom of man" Winwood Reade has endeavoured to trace the origin of civilization. In one passage he remarks :—

> "A people can never rise from low estate as long as they are engrossed in the struggle for daily bread. On the other hand, leisure alone is not sufficient to effect the self promotion of man."

He goes on to point out that civilization first arose in countries where periods of plenty were broken at recurring intervals by periods of famine. Referring to the ancient Egyptians he states :—

> "The Egyptians were islanders cut off from the rest of the world by sand and sea. They were rooted in their valley; they lived entirely

upon its fruits and happily those fruits sometimes failed. Had they always been able to obtain enough to eat, they would have remained always in the same savage state."

In another passage speaking of the early civilizations of Egypt, Babylonia and India Proper, or the Punjab, he remarks :—

"Each in a similar manner had been fostered and tortured by nature into progress."

The theory thus expressed that civilization owes its origin to a succession of shocks producing profound though more or less temporary changes in the environment of a race, is supported by the fact that it is possible to trace such a sequence of events, recurring periods of plenty and scarcity, prosperity and adversity, in the early history of every civilized people.

But periods of scarcity or famine suddenly following upon periods of comparative prosperity are recognized as being most potent factors in the production of widespread epidemics of disease, whether among men or animals; so that we should expect to see these two phenomena, famine and pestilence, marking the advance of any race towards civilization, especially in the early stages of the process. And if we refer to the history of Great Britain we shall find that during many centuries, indeed, as long as the population of that country was dependant upon a home grown food supply, the advance of that nation towards civilization was marked by the recurring phenomena of serious famine and apalling epidemics of disease. At one time in its history England was notorious all over Europe because of the frequency and severity of its famines, and during hundreds of years malaria, plague, sweating sickness, relapsing fever, typhus and smallpox recurred again and again and decimated the people. Every advance in civilization also appears to have actually furthered such outbreaks. When the country first became a maritime power infection was introduced from Europe; improved internal communication brought about the rapid spread of epidemics from place to place; the development of industries led to the rapid growth of industrial towns where thousands of people were huddled together under the worst conditions, and so provoked alarming outbreaks of typhus and relapsing fever. The very introduction of machinery indirectly brought about disease by the condition of starvation and misery produced among the thousands of families deprived of their only means of support.

But just as famines appear to have played a part in promoting civilization, so has the occurrence of epidemic disease always eventually resulted in a corresponding improvement in the race and the conditions under which it lives. The life of primitive man like that of other animals is usually exposed only to such disturbing influences as exceptional seasons, unusual cold, wet or drought which by reducing his food supply or otherwise lessening his normal power of adjustment to the parasites by which he is infested, lead to the rapid elimination of the less resistant members of the race by death. But in proportion as a race has advanced along the path of civilization, its environment has undergone profound changes. At every step the life of the people has been altered; and the race has thus been exposed to a series of extra-ordinary shocks, by which the normal balance of existence has been continually upset. At each recurring shock individuals who are unable to adjust themselves to the new conditions, pay the penalty of inefficiency; the strain imposed upon them prevents them from holding their parasites in check; and these, increasing in number, bring about a condition of disease which in a large proportion of cases ends in the death of both host and parasite. Thus by a slow process of evolution, recurring periods of health and disease, a race is gradually purged of its parasite-carriers and with them of its parasites. It is by some such process as this that civilized man has largely rid himself of the parasites which used to infest his more primitive forefathers. It must be expected therefore that as a primitive race advances towards civilization manifestations of epidemic disease should occur from time to time with a frequency and intensity proportionate to the rapidity of its progress; and these recurring phenomena will continue until a condition of comparative

freedom from parasites has been attained. Such appears to have been the course of events in Great Britain, and the result has been that malaria and many other parasitic conditions, at one time of common occurrence there, have now completely disappeared.

It must not be forgotten however that side by side with this process of elimination of parasite carriers and parasites owing to the greater stress imposed upon mankind by civilized life, another influence has been at work, assisting to bring about a condition of freedom from parasites. The epidemics of disease brought about among parasite laden races by the shocks of advancing civilization have had the effect of stimulating mankind to direct attacks upon disease with a view to its control. And it is natural that this should be the case. So long as man's parasites cause him little or no inconvenience, he tolerates their presence; but when they disturb his comfort or threaten his existence he is often aroused to attempt to rid himself of them.

But there is little reason to suppose that the conscious struggle of man against disease, which has only become effective in quite recent years, has played a very important part in freeing countries like Great Britain from parasitic infestations such as plague, leprosy, typhus fever, relapsing fever and malaria, which were at one time prevalent there. And except in the case of malaria and small-pox ,it is difficult even to guess at the special causes for the disappearance of these conditions. But although there is no direct evidence to show that malaria disappeared as the result of measures specially directed against it, it is possible to point to certain factors which have exerted a marked influence in bringing about its disappearance. And foremost among these influences has been improvements in agriculture.

Among the more primitive races of mankind who seek their living from the soil, the simplest forms of agriculture are practised. Each family tills a small plot of land no larger than will suffice for its few needs, in a manner requiring as little effort as possible. Land which is most easily cultivated is selected, the simplest implements are used, no manuring, no drainage and only the easiest forms of irrigation are adopted; and as soon as the soil in one place is exhausted another site is chosen. So long as the 'pressure' of population is not very great these simple methods suffice to supply the wants of the people in ordinary seasons and there is no incentive to improvement in the system of agriculture. But with advancing civilization man's wants expand, and to supply them he tills a larger area than that required merely to provide him with food and clothing; and by a system of barter exchanges his surplus crops for other products. Gradually as communication with outside markets improves, the demand for all kinds of raw material increases and under the further stimulus of a system of monetary exchange, which soon replaces the primitive methods of barter, agriculture tends to undergo a rapid process of evolution. As manufacture develops, the demand for all sorts of raw material expands, and land at one time used for food crops is turned to other purposes. Partly as a result of this, and partly owing to the fact that large numbers of people who once produced their own supply of food are now engaged in other industries, the price of food stuffs rises, and in sympathy with this rise, the value of all agricultural produce increases. This brings about increased demand for land which in turn produces a rise in land values and a corresponding increase in rents. As land increases in value owing to the greater demand, areas which in earlier days were left uncultivated are gradually brought under the plough, waste land and jungle are cleared, swamps and lowlying land are drained. The cultivator also taught by experience that continued cropping of the soil produces exhaustion, learns to make use of manure, to adopt rotation of crops, selection of seed and advanced systems of irrigation and agricultural drainage. In other words he no longer looks upon the land as a mine to be worked till exhausted and then abandoned, but as a machine for turning labour into wealth.

By the time he has reached this advanced state of development he can obtain from the poorest land as much or more return than was originally yielded

by the best and the face of the country has undergone a complete change from a waste of forest, undergrowth, and swamp, broken here and there by small patches of cultivation, to a wide expanse of cultivated fields, open pasture and regulated plantations of useful timber and orchard trees. But it is not only the surface of the land which undergoes a change. As soon as the value of agricultural products rises above a certain level, capital is attracted to the land and the large farmer enters into competition with the petty cultivator. And with the rise in rents, the necessity for using manure, machinery and other adjuncts of intensive cultivation the competition becomes so severe that the small holder is gradually ousted, because he possesses neither the capital, the knowledge nor the ability to exact a full return from the soil. With the elimination of the small cultivator and the introduction of efficient machinery the number of people permanently engaged in actual cultivation of the soil is greatly reduced, the rural population diminishes and that of the towns increases.

The status of those concerned in agriculture also changes. Instead of a multitude of small cultivators working their own holdings mostly unaided, we have a smaller number of large farmers employing labourers; and though the lot of the farm labourer under these conditions is by no means enviable it is infinitely superior to that of the landless man, among a community of small cultivators; moreover the presence of the large farmer with his superior education and higher standard of living has an effective influence in the civilization of the rural areas. Under the improved system of agriculture an increased amount of wealth is returned from the soil; and this is shared although unequally by all those engaged in husbandry. The result of this increased prosperity is shown by the improvement in the material condition of the whole rural population. People are better fed, better housed, better clothed; they indulge more frequently in an increasing number of simple luxuries; their children go to school; and their sick receive skilled attention.

Such changes as have been thus briefly described signify a tremendous modification in the environment of a race. And whenever they occur man's relation to malaria undergoes a complete alteration; for the conditions under which he lives are no longer favourable to the existence and spread of the parasite. It has often been stated that malaria has been eradicated from a country by drainage alone or by drainage combined with the clearing of jungle. but it appears more likely that a development, more or less rapid, of the whole system of agriculture in a locality, involving not only drainage and clearing of jungle but a number of other changes in the environment of the population concerned, has been responsible for the reduction or disappearance of malaria from the country.

Many years ago, while England was still producing its own food supply the high prices obtained for wheat stimulated the exportation of this grain to continental ports. This export trade was still further encouraged by the offer of a Government bounty on every shipment. It is possible that this circumstance was partially responsible for the reclaiming and cultivation of vast areas in the few districts. These districts at one time notorious on account of malaria subsequently became famous for their wheat production and still produce a large amount of grain. Huge areas of low-lying land in that part of England, much of it situated below sea level, have been reclaimed by a system similar to that adopted in Holland. The rivers flowing through that part, which at one time overflowed the country after every heavy fall of rain, have been retained within embankments; sluices are used to regulate flood and tidal water; and to drain the land a net work of low level drains or dykes, together with high level drains upon embankments is employed. Windmills were originally used to work the pumps required for raising the water from the low to the high level drains; but these have now been replaced by steam plant; and the same plant which in wet weather removes the excess of water from the fields is used in time of drought for irrigating the land from the rivers and high level water channels.

But although the system of reclaiming and draining a country in this way, has had an immense influence in bringing about a reduction in malaria, it would be a mistake to infer that the same results would follow the adoption of schemes

of drainage aimed at the mere reduction of malaria, rather than the development of agriculture. Attention must also be called to another important point in this connection. The freeing of the fen districts of England and the greater part of Holland from malaria has been achieved not by the expenditure of vast sums on sanitation by the State, but by the enterprize of private persons. And the farmers and landholders who have been instrumental in effecting this improvement have been stimulated to carry out this work not with a view to improve the health of the country, but because they wished to increase or secure their own profit.

Turning to India it may be observed that the vast mass of the population is still in a very primitive condition. The coolie, the cultivator, the petty trader and craftsmen still live a simple life, with few and easily satisfied wants. They are still mostly without education ; and the only ambition they possess is the wish to live as their forefathers have done for centuries. In common with other primitive peoples the masses of the population support an extra-ordinary variety of parasites ; and under ordinary conditions and so long as they have sufficient food, water, clothing and shelter, in other words, so long as their environment remains unchanged, and their adjustment to it in balance—disease occurs only as a very minor phenomenon amongst them. But within the past fifty years a series of extraordinary changes have been going on all over the country, and the environment of many millions of the people has undergone enormous modification. The construction of many thousand miles of railway, the covering of the country with a net-work of roads, and the organisation of fast steamer services around the coast and on the inland waterways have simplified means of communication, and given rise to an active export and import trade. Millions of cultivators in Bombay, Bengal and the Punjab whose fathers were engaged merely in the production of the few necessaries required for their own families, are now busy supplying not only the markets of Bombay and Calcutta, but those of the world, with cotton, jute and wheat. Side by side with these larger changes a host of smaller ones has been brought about, affecting every district. Old village industries have dwindled ; the small weaver, the oil maker, the lime burner and a host of other petty crafts are fast disappearing ; trade is now everywhere conducted through the medium of currency instead of barter ; wages are everywhere paid in coin instead of in kind. There is not a single advance towards civilization that has not brought about a huge modification of the environment of the people. The development of the Tea Industry in Assam, the coal mines of Bengal, the Jute mills of Calcutta and the cotton mills of Bombay has entirely altered the life of millions. Even the introduction of a postal and telegraph system, the laying of cables to Europe, and the construction of the Suez canal, have exerted a profound influence upon the people, for the cultivator in Bombay, Bengal and the Punjab has thus been brought into direct relation with the markets of the world, and fluctuations in the price of cotton, jute or wheat on the exchanges of Europe may bring him either prosperity or adversity.

Partly as a direct result of all these changes and partly from other causes but mainly because India is now linked up with the world, there has been a steady and continuous rise in the cost of living ; and the increased price of food together with a gradual improvement in the standard of comfort is rapidly effecting a great intensification in the struggle for existence among all classes of the community.

Thus in the brief space of fifty years a change so vast as to be almost inconceivable has been effected in the environment of a primitive, parasite-laden race. And as a direct result of the successive shocks by which this change has been brought about, the balance of life of myriads has been again and again upset ; the delicate adjustment by which their parasitic infestations were kept in control been broken down, and appalling epidemics of disease been brought about amongst them at frequent intervals. And the poorest, the most ignorant, the most parasite laden and least adjustable classes of the community suffer most severely at the time of these epidemics, demonstrating by this fact their inability to meet the strain of life under the changing conditions of advancing civilization.

Briefly summarized the conception which has been outlined in the foregoing pages may be stated thus :—

Parasitism and parasitic infestation are universal conditions of life; and man in common with all other animals is the natural host of many species of parasites. But civilized men when contrasted with primitive man is comparatively free of parasitic infestations, the conditions of his life being less favourable to the existence of parasitic organisms. Under natural conditions all organisms become adjusted to their environment, including their parasitic associates, and disease as generally understood either does not occur amongst them at all or only appears as a very minor phenomenon.

But sudden changes of environment such as that occasioned by unusual seasons may upset the balance of life and give rise to serious manifestations of disease, in the course of which the less resistant members of a race or species perish.

In common with many other parasites the malarial organism is to be found associated with man wherever the conditions of his life lend themselves to its existence; and as primitive races generally live under conditions favourable to malaria they are frequently found to be infested with the organism.

Primitive man like other animals is normally in a state of adjustment to his environment, which includes numerous parasitic infestations, to which under ordinary circumstances he is tolerant. But any change in his environment at once modifies his relationship to these parasites; and in proportion as it is sudden and severe may lead to a manifestation of disease.

Primitive man is usually only exposed to such temporary changes in his environment as those occasioned by exceptional seasons. But the advance of a race towards civilization is marked by recurring changes in its environment, often extraordinarily serious in their character.

In the process of civilization individual members of a race who fail to adjust themselves to the changing conditions of life, succumb to the strain, and fall victims to the attacks of the parasite to which they have previously been tolerant.

Epidemic disease is a natural accompaniment of the early stages of advancing civilization; and it is a beneficient process; because in no other way can a parasite laden race so speedily rid itself of its parasite carriers and parasites.

The phenomenon of epidemic disease is thus always the result of a change in environment. When it occurs among primitive races it is usually due to (A) exceptional seasons, or (B) changes of advancing civilization. Under both these conditions, previously tolerated parasites give rise to disease. But the change of environment producing disease among a population may itself be the presence of an unfamiliar parasite. The changes of environment producing epidemic disease among highly civilized races appear to be usually of this character.

Viewed in the light of this conception the problem of disease takes on a new aspect. Epidemics whether of malaria, plague, cholera and other infective disease to which such races as those occurring in India, China and Russia are prone, appear no longer mere isolated, inexplicable catastrophies; but as perfectly natural phenomena, fundamentally related to each other, however profoundly they may differ in their manifestations.

And the investigation of disease, or to use Metchnikoff's expressive term "disharmonies" becomes essentially a study of man's relationship to his environment, of which parasites form only a part. It follows that the investigation of the causes of malarial disease among a population, necessitates a consideration not only of the parasites of malaria and anopheline carriers which may represent only one factor in the condition, but an enquiry into every detail of human environment with a view to determining that special circumstance which has occasioned the outbreak.

And in this connexion attention may be drawn to the magnificent work accomplished many years ago in India by the officers who were deputed at various times to invesitgate the great epidemics of "fever" in Jessore, Burdwan and other places. Re-examined in the light of recent knowledge many of their reports may be found to contain a veritable mine of valuable observations.

Turning to the question of diseases control, it may be stated at once, that the measures suitable and necessary for the protection of a highly civilized population can rarely be successfully applied among primitive races. And the attempt to enforce them among parasite infested communities may be likened to rescuing a man from the jaws of a tiger only to see him disappear within those of an alligator.

And herein we may see the explanation of such anomalous occurrences as those to be traced in the history of Bombay City, where enormous reductions in the mortality from cholera and small-pox respectively, following upon the improvement in the water-supply and the introduction of compulsory vaccination, had no appreciable effect in reducing the total mortality.

In a country like India, therefore, the more highly specialized forms of sanitation, such as have been devised in recent years against yellow fever and malaria, must be applied with discrimination. They should be adopted in large cities with enlightened populations, among troops and jail communities, and in connexion with such industries as tea planting, mining etc., for under such conditions they are most likely to offer a return commensurate with the expenditure incurred. They are also called for in rural towns, but more especially for educative reasons. And in such places on no account should this educative function be sacrificed to the often futile attempt to obtain immediately obvious results. No doubt the State by the deputation of specially skilled officers and the grant of funds can carry out specific measures against malaria, much more efficiently than the municipal commissioners of a small town; but the effect of such work when done by Government is to undermine the independence of the towns-people, impair their sense of responsibility, and stifle effort at self improvement. And so, though at first municipalities will do the work very badly, they must be stimulated and encouraged to undertake it independently of Government aid.

Turning to the problem of malarial disease and infection in the rural districts, it will be apparent that except in rare instances the application of specific measures against the condition, can only have the effect of a palliative. The whole question of rural malaria in India, whether occurring as a mere infection or a disease manifestation, is bound up with the problem of agriculture.

The attempt to reduce malaria by such measures as drainage or the clearing of jungle unless accompanied by an extension and improvement in cultivation, is foredoomed to failure. And instead of dissipating large sums of money in the vain hope of reducing the incidence of malaria in a few localities in rural areas, attention should be concentrated upon improving the existing methods of agriculture by every possible means. To this end not only should special efforts be directed to educate the cultivating classes of the population, develop their intelligence, foster their ambition and independence, and improve their standards of comfort, but attempts should be made to induce capitalists to undertake large scale agricultural operations wherever possible.

And in this connexion it may be pointed out that large scale drainage operations carried out for the purpose of extending or assisting cultivation, provided they can be made self-supporting, appear to be among the soundest of anti-malarial measures for rural areas.

The chief function of the State in regard to problems of sanitation should be mainly that of educating the population. And although it may initiate reforms, the actual carrying out of the measures should be left as far as possible in the hands of the people concerned, for without their intelligeut co-operation no scheme of improved sanitation can be made effective.

In conclusion it may be pointed out that just as we can trace the origin of many epidemics of disease among a primitive people, to the changes wrought upon their environment by advancing civilization, so it is to civilization carried to a greater length that we must look for the remedy to these conditions. And although we shall not in our day see the elimination of malaria from India, we may rest assured that it will be accomplished in the future, as certainly and as completely as it has been brought about in England.

SOME PROBLEMS PRESENTED BY MALARIA IN BENGAL.

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In many parts of Bengal areas are to be met with in which a decrease of population has been steadily taking place for a number of years past. A heavy mortality from "fever" is invariably reported from these places, and the total of recorded deaths usually exceeds the births year after year.

The affected areas are frequently on a slightly higher level than other portions of the districts in which they occur, and are comparatively dry and exempt from flooding. They are often in closer relation to existing railways, and are better supplied with roads than other less affected portions of the country. Very frequently they appear to be associated with the presence of dead or dying rivers and stagnating *bheels*.

The villages in the affected areas are invariably overgrown with more or less dense jungle; the tanks are weedgrown, broken and neglected; and much of the land in the neighbourhood has gone out of cultivation.

In the villages the houses are few in number and often widely scattered; but although the number of inhabitants is now greatly reduced, there is evidence of a onetime numerous population; for the jungle is full of mounds which mark the site of long abandoned dwellings, and among them are to be seen the remains of huts more recently deserted. Here and there also among the trees and undergrowth the ruins of brick buildings may be met with often of considerable pretension, pointing to a period of prosperity that has now passed away. An increase of malaria is usually assigned as the cause of this melancholy phenomenon; and examination of villages in affected areas has invariably shown them to possess high spleen and parasite indices, showing that a heavy incidence of malarial infection is certainly associated with the condition.

The grave nature of the evil is forcibly illustrated in the following letter recently received.

"SIR,

I have the honour to say I am an inhabitant and also zamindar of a village "named Madhabpur . . . . which is now on a verge of depopulation, owing "to malaria. The village is lying on the river Kumar which is about to be sealed up. "About twenty years ago we had more than a thousand people in our village, but now "we have only a hundred men. What a horrible thing it is!"

The writer goes on to add that he has gone to Calcutta for treatment and purposes going elsewhere for a change of air on account of his health.

It is frequently suggested that a water-logging of the country has been responsible for an increase of malaria. And this condition of supposed water-logging is ascribed either to the silting up of the *khals* and rivers and the stagnation of the *bheels*, or to an interference with the surface drainage of the areas by the construction of roads or railways. Another view frequently put forward is that the increasing growth of jungle in and around the villages is the cause of the trouble. And a third idea occasionally mentioned is that the extensive steeping of jute has led to a fouling of the water, or favoured the increase of anopheles mosquitoes and so brought about an increase of malaria.

But in spite of the fact that investigations into the condition have been made from time to time, and suggestions even put forward for dealing with the supposed origin of the trouble by huge drainage schemes, no satisfactory explanation of the phenomenon has as yet been forthcoming and these areas of dwindling population and decaying prosperity still present the most serious problem associated with Bengal malaria.

In a paper prepared for this conference entitled a New Conception Regarding Malaria, attention has been drawn to the fact that the occurrence of epidemics of infective diseases among a population is a phenomenon invariably resulting from some serious alteration in its environment, whereby conditions formerly favourable to life have become unfavourable. And although the introduction of an unfamiliar parasite among a race constitutes a specific change of environment almost invariably giving rise to disease, in communities already parasite-laden, a more general modification of environment such as that brought about by exceptional seasons or the advancing movement towards civilization has more frequently to be considered.

Epidemiology therefore involves a study of populations in relation to their environment, of which their special parasites form only a part; and the proper investigation of malarial disease necessitates an examination of all the factors influencing the life of the affected community besides those specially related to the actual condition of infection.

Therefore an enquiry into the phenomenon described in the opening paragraphs of this paper, must as far as possible take cognisance of every fact relating to the life of the population of the affected areas.

Bengal and the Ganges.—The Ganges is the mother of Bengal. Nearly the whole of the country has been deposited from the waters of this mighty silt-laden stream. And the process which originally gave birth to Bengal is still continuing at the present time. Age after age has watched the delta of the Ganges slowly extending, pushing into the sea further and further to the south and east, and gradually encroaching in this way upon the Bay of Bengal. Thus it has come about that the portions of the delta which lie to the south-east are of much more recent formation than those to the west.

And century after century as these new lands have been formed, the relation of the Ganges to the older land which it has previously deposited and through which it flows, has undergone a change. The water has gradually receded from the land, most of which now rises well above the level of the river; and areas at one time subject to the usual recurring inundations, whenever the river was in flood, have gradually ceased to experience them; their soil has become drier; and they are now dependent entirely upon rainfall for their fertility.

And while this change has been taking place in the land forming the older and more westerly portion of the delta, a corresponding change has occurred in connexion with the many subsidiary river channels which exist there, and through which much of the water from the main stream of the Ganges at one time passed to the sea. Sandbanks are gradually thrown up by the main river obstructing the openings through which the subsidiary channels take their supply of water, the rapidity of their flow is lessened, and silt is deposited at every bend in their course. As their channels become shallower this silting up process becomes more marked and the width of the stream is also reduced. Finally communication with the main stream of the Ganges ceases, and the moribund channels degenerate into* *jheels*, or remains as sluggish weed-grown streams fed by the overflow of rainwater from some stagnating* *bheel*.

It is in the older portions of Bengal, that have passed through these successive changes, and in which the phenomena of dead and dying rivers is a common occurrence, that the areas undergoing depopulation, referred to in the opening paragraphs of this paper, are most frequently to be seen.

Situation of villages.—It is a usual thing in Bengal for villages to be situated upon the banks of rivers and khals, partly because in these situations the land is sometimes slightly higher than the surrounding country, and forms a more suitable site for dwellings, but more especially because a supply of good fish is obtainable there, means of communication are easy at all times of the year, and water is always available for domestic and other purposes. The land in the neighbourhood of rivers is also usually better than that at a distance because it is constantly being enriched by the deposit of silt, which occurs whenever the streams overflow their banks during the rainy season.

This phenomenon of annually recurring inundations occurs in association with a large proportion of active rivers in Bengal. And it is one of the prime causes of changes in their course and the silting up of their channels. These changes are

* A *jheel* is a collection of water in part of an old river channel. A *bheel* is an ordinary marsh.

constantly taking place in the rivers of Bengal. But apart however from the natural tendency for such changes to occur in silt-laden streams, the condition is frequently brought about or hastened by the almost total neglect of river conservancy, and streams that are most important means of communication and trade thus sooner or later become irretrievably damaged. This habitual neglect of the waterways in Bengal was commented upon by Buchanan more than 100 years ago.

He states :—

"On the whole it must be evident, that changes in the course of the rivers "are attended with great loss and inconvenience. The new channel is so much land "lost, and the old one leaves behind it a marsh or kind of lake, which for ages is "rather injurious than of use. At the same time the vicinity of the new course is "deluged with water from the smallness of the channel, and the banks of the old "course are often deprived of fertility, and still more certainly of the means of "conveying their produce to market. The towns must therefore disappear.

"In a country so level and of so loose a soil, such sudden changes cannot "perhaps be altogether prevented. All that I can propose for the purpose, is to "remove in the most usual cause of change, which is the trees that fall into rivers, "and which collecting sand around them form banks, that obstruct the channel, and "not only occasion great and sudden changes in the course of the rivers, but impede "navigation. On the moulding bank of every river may be observed trees growing "close to the precipice, gradually undermining, and then falling in and lying to rot; "for the proprietor will not allow them to be cut or removed, while growing; and "afterwards they are in general of no value except for fuel, and the expense of "cutting them for that purpose exceeds the means of the neighbouring poor. Some "of the kinds are venerated by the Hindus who consider it as sinful to cut them. "I am persuaded therefore, that it would be a useful regulation to direct, that every "landholder should remove trees which are growing within 20 feet of a moulding "bank, and when he neglected or avoided doing it, that a proper officer of police "should clear the bank, and charge the proprietor a reasonable price for the "labour."

Another cause of this silting up of rivers is the obstruction of their channels by bamboo screens and fish traps which in the smaller streams may often be seen placed at intervals of a few yards along the whole length of either bank. These fish traps are usually especially numerous where the water is shallow, and already in process of being silted up.

Larger or smaller *bheels* or *jheels* are to be found throughout Bengal. Some of these have been formed by the deserted beds of old river and others in areas of low-lying land; but nearly all are, or have at one time been, in direct or indirect communication with live rivers. In some cases these appear as enormously wide expansions of the ordinary river channels when in flood during the rainy season. In these cases they resemble lakes with rapid currents either in the centre or at one side or another. In other cases they do not communicate so directly with the river but serve the purpose of overflow reservoirs into which flood water passes whenever the level of the river reaches above a certain point. In either case they act the part of silt traps and as a result always tend to undergo a natural shrinkage. *Bheels* in connexion with dead rivers have reached the stage in which they no longer receive surplus river water but merely collect rain water which drains into them during the wet season.

Owing to the continual changes that have been going on in the river channels of Bengal it follows that villages originally situated upon the banks of running streams are now far removed from the active channels, and are to be found upon the sides of dead and dying ones. Similarly villages originally situated upon active *bheels* are now to be found associated with stagnant ones.

Population.—The population of a typical Bengal village may be classified in many different ways: (1) according to religion into Hindus and Mussalmans; (2) according to education into literate and illiterate; (3) according to social and economic condition into *bhadra lok*, and *chhota lok* and (4) in relation to the land, as land-holders and landless. The most important distinctions for the purpose of our enquiry appear to be (3) and (4).

Literates are more common among the Hindus than the Mussalmans; and the majority of the *bhadra lok* are educated, but only a few of the *chhota lok* are literate. The prime distinction between *bhadra lok* and *chhota lok* is that of education and economic position; and the possession of comparative wealth usually carries with it a corresponding position of social importance and influence in the community. *Zamindars*, and the *talukdars* or *jotedars* immediately under them, professional men, such as pleaders, doctors, schoolmasters and others, and wealthier traders, form the *bhadra lok* of a village. But absentee landlordism has become a feature of life in Bengal, especially in the more unhealthy areas, and *zamindars* usually reside in Calcutta or the larger towns and not in the villages. Of the larger landholders under the *zamindars*, many are Hindus. It is from among zamindars and this class that professional men, pleaders, doctors and many of those engaged in Government service are drawn. *Talukdars* and *jotedars* often hold from 25 to 100 or more acres of land under the local *zamindar*, but they never engage in cultivation. The land held by them is sublet in small plots to smaller landholders called *dorjotedars* who again sublet it, or to actual cultivators.

The *chhota lok* of a village include all those who till the soil, fishermen, petty traders and craftsmen, menials, labourers and beggars. Fishermen sometimes cultivate land, and Mussalman *jolahas* and Hindu *tantis* also frequently engage in agriculture in addition to following their original occupation of weaving. Other petty craftsmen to be found in a village are, oil-makers, lime-burners, backsmiths, potters, leather-workers, sweetmeat-makers, and those who prepare *chera*. In addition to these classes there are always a larger or smaller number of landless labourers. These people have either never possessed land or have lost their original holdings. They are employed as menials by the *bhadra lok* and also do field work for the cultivators who are in a position to employ others beyond their own household. But the condition of this landless class is extremely precarious as there is never the certainty of their obtaining regular employment. The classes dependent upon begging include religious mendicants, both Hindus and Mussalmans, and people who have been reduced to destitution. The former class often consists of strong healthy adults, the latter of old men and women, widows and children, and the deformed or otherwise afflicted members of the landless classes.

Economic condition.—With the exception of the fishing population and those families of whom some members are engaged in service, etc., in distant places, the whole population of a typical village from the highest to the lowest is dependent directly or indirectly upon agriculture. The *zamindar* is dependent upon the income derived from his land; the *talukdar*, or *jotedar* class, live upon the difference between the rent they pay to the *zamindar* and that received from their sub-tenants together with commissions of various sort upon the sale and exchange of cultivation rights; the *dorjotedar* obtains his living in a similar manner, but on a smaller scale; the cultivating classes who form the bulk of the population are dependent upon the return they can get from their land; the shopkeepers, petty traders and craftsmen of all kinds upon the local demand for their goods or services; the landless classes for employment on the land, and domestic service among the *bhadra lok*; and the destitute upon local charity. Thus from an economic point of view the whole village may be considered as a unit. Good seasons and plentiful harvests mean prosperity for all. Excessive or unseasonably rain, heavy floods, severe storms, prolonged drought if at all general in their incidence result in a period of adversity which affects the well-being of every individual in the community.

Jungle.—With hardly an exception villages in Bengal are surrounded with a more or less luxuriant growth of trees, shrubs and undergrowth. It is only those of very recent origin which are not more or less completely hidden in this way. This peculiar character of Bengal villages was remarked by Buchanan 100 years ago, and he describes it as follows :—

"The great variety of lofty flower and fruit-bearing trees, and the luxuriant "bamboos by which the cottages are shaded would render their situation delightful, "did not rank weeds and bushes, which shoot up with increasing vigour in every "corner that is not in constant cultivation, prevent all circulation of air, preserve a "constant damp noisome vapour, and harbour a great variety of loathsome and perni-"cious animals. The poverty, shyness and indolence of the natives, especially the two

"former, prevent them from removing those nuisances. They are fond of having their "houses buried in a thicket which screens their women from view. These thickets "serve them as a place of retreat in all their occasions, which adds very much to the "noisome smells that they produce."

He mentions in another place that—

"By far the greater parts of the forests owe their origin to deserted towns and "villages. The trees which grow round these have gradually increased and have "given shelter to some others that are not usually found in such situations."

Tanks.—Another common feature of Bengal villages is the existence of a multiplicity of tanks, a few perhaps in use, but almost all in a state of neglect. Buchanan observed this condition also.

He remarks :—

"These tanks are also extremely useful by supplying the inhabitants with "water, not only for domestic purposes, but for the irrigation of the fields. The "persons therefore by whom they have been constructed are justly entitled to much "praise, wherever they have had the utility of the tanks in view ; but ostentation and "the desire of fame, have increased the number and size of these works to a destruc-"tive extent ; especially as no one is sufficiently interested in their repair, which is "attended with no reputation. Almost every tank therefore is soon choked with "aquatic plants, and become a source of noisome smell, bad water, and disease ; while "there are infinitely more tanks than the inhabitants of the place can occupy, and "much land is for ever rendered useless. It were indeed very much to be wished, "that . . . . the digging new tanks should be altogether prohibited, at least "none should be permitted without an investigation into the necessity for its construc-"tion, and without proper security being taken from the estate in which it is dug, for "its being kept for ever in repair and free of noisome weeds . . . . However "desirable it might be either to have the old ones cleaned or filled up, the means I "confess are not obvious."

Roads and Railways.—In Bengal generally areas above flood level are better provided with roads than those below it. There are several reasons for this. Because they are not well supplied with navigable streams, there is a necessity for the existence of roads ; and because it is an easier and cheaper business also constructing roads and maintaining them in a state of good repair in dry areas than in those subject to flooding, there is a further inducement to their multiplication. Thus it comes about that areas away from live rivers, no longer subject to recurring inundations, possessing a large proportion of comparatively poor land * (*dangi land*) are far better supplied with roads than lower lying areas, subject to annual floods and containing a larger proportion of fertile soil † (*bila land*).

And just as the contour of the land largely determines the presence of few or many roads, it also influences the question of railway construction. To carry a railway across miles of low country where there are many rivers constantly overflowing their banks and changing their courses is an exceedingly difficult and expensive matter. And so in Bengal railways are usually to be found on land that is on a fairly high level. And as railways invariably require feeder roads, the presence of a railway track passing through the higher-level portion of a district, already better supplied with roads than places at a lower level, brings about a still further increase in the number of roads there.

Railways have frequently been blamed for causing the silting up of rivers which the line has to cross ; and it is usually suggested that the bridges are made too small and so lead to the gradual choking of the channels. But in the majority of cases there is little evidence to show that rivers have been damaged by bridging ; and the existence in the same areas of channels which have been completely blocked for years before the construction of railways, points to other and more natural causes having originated the trouble.

But the construction of roads and railways in a district has a very great effect in modifying the environment of the people in all manner of ways. The embankments of roads and railways alter the physical condition of the country to some

* *Dangi* land that which is above flood level.
† *Bila* land is that which is subject to inundation.

extent, and the burrow pits from which the earth for these embankments is obtained form series of hollows in which water collects during the wet season. There is also some tendency for road and railway embankments, especially when first constructed, to hold up collections of surface water, and many acres of land are sometimes submerged as a result.

Besides these changes there are others that are probably more important but are often overlooked. The existence of roads and railways leads to the necessity for carting, and thus a carrying industry, requiring carts, carters and draft cattle, springs up in an area in which perhaps it was almost unknown previously. The presence of a railway brings a district into communication with large centres of commerce, which stimulates some branches of trade and ruins others. For instance weavers, oil-makers, lime-burners and a host of other petty craftsmen who were supported by the local demand for their productions, feel the competition of imported cloth, oil and lime, etc., and find their trade dwindling. On the other hand, cultivators and others benefit by being able to secure a ready sale for their products in outside markets.

Agriculture.— Bengal is naturally one of the most fertile provinces of India and probably because of this fact the system of general agriculture practised in many parts of the country, especially those situated in the delta of the Ganges, is far more primitive and wasteful than that to be met with in less favourably situated places. The average cultivator takes as much as he can get out of the land, with the least trouble possible to himself; and he puts nothing back.

Just as the cultivator in the plains of Egypt and the delta of the Nile has been accustomed to depend upon the annually recurring inundations for the enrichment of the soil, so over vast areas in Bengal the *ryots* look to the flooding of their fields, by the overflow of the many silt bearing rivers, for the production of rich crops of jute and *dhan*. And when in process of time a river changes its course, or a channel becomes silted up, and they no longer receive its supply of wealth producing water, the cultivator, too ignorant and too poor to make use of manure, is gradually reduced to poverty and destitution by the rapid impoverishment of his land and the consequent dwindling of his crops.

It is a well known fact that the cultivation of rice appears to impoverish the land upon which it is grown but slowly; and land so cropped continues to give but a slightly diminished yield for long periods. But it is quite otherwise with crops such as sugar-cane and jute, both of which appear to rapidly exhaust the land upon which they are grown.

And in the last fifty years the demand for jute has increased so enormously, and the price has advanced so rapidly that the *ryots* all over Bengal have been tempted, wherever possible, to cultivate this crop year after year to the exclusion of others; and though in areas of more recent formation still receiving the overflow from rivers, the result has been a rapid advance in the prosperity of the agriculturists; in parts where the land is older and from which the river floods have permanently receded, a rapid impoverishment of the soil has been brought about, involving entire communities in ruin.

Economic changes.—It is frequently assumed that, under existing circumstances when the price of agricultural produce such as jute and *dhan* is high, the condition of the village communities of Bengal is one of very great prosperity. But although in many areas the cultivator is now exceptionally well-off, this condition is not by any means universal and in any case those who are not cultivators have suffered considerable hardship by the great rise in the price of foodstuffs.

But some areas are very much more prosperous than others. Tracts possessing fertile soil along the banks of silt-bearing streams, *bheel* areas which are still in receipt of silt-bearing water, and *chur* lands which are constantly being thrown up anew by the big rivers, are usually extremely fertile and produce year after year enormous crops of jute and paddy. And in these areas the condition of the people generally is one of considerable prosperity.

But in places which are now well above flood level, those that are situated close to dead or dying rivers and bheels which have become stagnant or are rapidly stagnating, a very different condition of things prevails; for much of the land in these situations has become so impoverished, in the absence of fertilizing inundations, by

years of primitive cultivation without manure, that it produces only a fractional part of the outturn at one time obtainable from it; and the income per *bigha* derived by the cultivator may be only a half, a quarter or an eighth of that received by the agriculturist in new and more fertile areas.

Good *bila* land in the most fertile tracts of Bengal will produce as much as 30 to 40 maunds of paddy and 6 to 10 maunds of jute per *bigha*. But from exhausted dangi soil, from 5 to 10 maunds of paddy and from $\frac{3}{4}$ to $1\frac{1}{2}$ maund of jute is probably the average return.

Another factor which tends to undermine the prosperity of the villagers in many districts, but whose effects are most apparent in the less fertile areas, is the constant sub-division of individual holdings which has gone on in some cases generation after generation. Thus originally a cultivator might be possessed of land sufficient to supply all the wants of his family and maintain them in a condition of comfort. But should he have several sons, it may happen that eventually three or four families have to be supported on the income which originally kept one in comfort; and if capital to pay the necessary *shalami* on a further acreage is not forthcoming or supposing no more land is obtainable, the several families sink gradually to a condition of poverty. And when in a village community in addition to this repeated sub-division of holdings, the soil itself becomes progressively impoverished, an appalling condition of general poverty is the result, nearly the whole population being reduced to a state little above that of destitution.

But usually before this condition has been reached, the individual holdings of land have changed hands many times. And default in payment of rent on the part of some sub-tenants, the abandonment of holdings by others, and the general increased cost of living have reduced the small landholding gentry, *jotedars* and *dorjotedars*, to a condition of penury. When this occurs their numerous dependants, household servants, brahmins, *purohits* and mendicants suffer with them. Moreover as their capital has been invested in the land, they are tied to the locality. Year by year more and more land goes out of cultivation because original *ryots* are either dead or have migrated, and those left in the village have not the necessary capital to take it up; and no outsiders are willing to come forward to cultivate soil which offers them little or no return for their labour.

By this time other changes, originated or stimulated by the gradual impoverishment of the locality, tend to still further intensify the prevailing distress. As soon as the prosperity of a village begins to decline, the more wealthy and provident among the cultivators, who are also the most shrewd and enterprising, migrate to other places, and their example is followed by the more prosperous and independent among the craftsmen and petty traders. The position of the landless labourers now becomes pitiable in the extreme, for they can no longer count upon regular employment in the fields.

After a time the increasing poverty of the village population begins to be reflected in the health of the community and as a result the small gentry who are in a position to do so, also leave and remove their families. The population of a large village may therefore eventually become reduced to a small community composed of the most ignorant, most indebted, most weakly and poverty-stricken amongst the original inhabitants; who continue to drag out a miserable existence incapable of helping themselves and practically incapable of being relieved except by measures which would result in their wholesale pauperization.

Land tenure.—In Bengal as is well known the bulk of the land is held by zamindars who pay a fixed revenue to Government. Some zamindars dispose of *pattahs* direct to the cultivators, and collect the rent by the agency of *naibs*. But in many places a class of middle landholder has arisen, the *jotedar* or *talukdar*. These men obtain larger or smaller areas of land from the zamindar for the purpose of sub-letting it. Another class of landholder is also to be met with in certain areas, who obtains land for the purpose of sub-letting from the *jotedar*. These men are called *dorjotedars*. The agreements under which land is held vary considerably. Tenancy rights may be permanent or terminated by the death of the tenant. In the former case they may or may not be saleable. In the latter case they are not saleable.

Shalami has to be paid for every kind of *pattah*. This transaction is comparable to the purchase of the lease of a property, upon which ground-rent has to be paid. The cultivators have to pay *shalami* for cultivation rights. Similarly the *dorjotedars* and *jotedars* pay *shalami* for the right to let certain plots of land.

The question of land-tenure seems to be an important one; and it may be found that it has a considerable bearing upon such matters as impoverishment of the soil. But at present there is not sufficient data available to show such a relation.

Death and disease.—Whether among men or animals the vital necessaries of life are an adequate supply of food, water, and protection from climatic influences. The more primitive races of mankind are usually content when these and a few other very simple wants are satisfied. And this fact renders them very susceptible to the action of unusual seasons and other influences which tend to interfere with the normal course of their existence. For their wants are so few and so simple even in times of prosperity that temporary adversity speedily results in deprivation of the necessaries of life. Civilized man, on the other hand, has so hedged himself about with artificial wants that his margin of adjustment is very great, and temporary adversity usually means only the foregoing of a larger or smaller number of luxuries. Thus it happens that the members of a civilized race are largely exempt from the effect of those changes of environment which exert such an extraordinary influence upon the life of primitive races, and often result in the bringing about of epidemics of disease and a very heavy mortality amongst them.

The vast masses of the population of Bengal live in a condition of primitive simplicity. Food, clothing, shelter and a little tobacco represent the bulk of their wants. A little simple jewelry for their women and children, small gifts to their religious teachers, the keeping of festivals, and the giving of charity to beggars represent their luxuries; and expenditure on marriages and legal proceedings, their chief extravagancies. The bulk of the people live from hand to mouth. In time of hardship they turn to the money-lender and when he fails them they starve.

Observations among the rural population of Bengal point to the economic condition of village populations as being the main factor determining a moderate or excessive mortality among them. Communities whose members as a whole are well provided with the necessaries of life, have a mortality rate rather below the average for the province, whereas communities experiencing economic pressure invariably show a much higher death-rate.

The mortality among village beggars and the landless labourers is exceedingly heavy, because they are constantly on the verge of starvation. And villages possessing a large proportion of people of this class show a higher general rate of mortality than others. And among other classes also the occurrence of economic stress is immediately followed by an enhanced mortality. The death of a cultivator who is not in good circumstances and who possesses no adult male relations is almost invariably followed by the speedy death of other members of the family; and the same phenomenon may be observed in the case of petty traders and craftsmen. In this way even among communities that are apparently in a generally prosperous condition, whole families may be decimated, the death of the father being followed by that of all the other members, in an amazingly short space of time.

When a village returns an abnormal number of deaths it is usually not because the whole population is dying at a faster rate than usual, but because a number of families are undergoing almost complete extermination.

This fact is illustrated in the following cases :—

(1) In the course of a house-to-house inspection of a village in the Dacca district a family was seen, consisting of a widow, her mother-in-law and four children. Every member of the family was ill. The husband had died six months previously, and the family was reduced to penury. They still held the land, but they had been unable to cultivate more than a small plot of vegetables. They were entirely dependent upon the sale of these vegetables and small bundles of firewood which the women and children collected. As they were Mussalmans the women were unable to personally conduct the sale of these articles, and the children were too small to do so, so that they had to pay a neighbour to sell the vegetables and firewood

for them. They were in debt and an iron shed valued at several hundred rupees had been seized and removed by the *mahajan* Two children had died a few months after their father. A few weeks after the visit it was learned that both of the women and two more of the children were also dead.

(2) In a village of about 35 houses containing a population of approximately 175 souls only five deaths had occurred in the twelve months preceding the visit. These five deaths all occurred among the members of one family.

(3) In a village in the Faridpur district an examination of the chowkidars' hath-chittas revealed the fact that seven deaths had occurred in one family during the two months prior to the visit. A visit to the house and enquiry into the circumstances elicited the fact that the family had been reduced from comfortable circumstances to almost complete destitution by the destruction of their land owing to the cutting away by the river. A large family had been reduced to five members, the father and four children between the ages of 8 and 14. All the children were ill with malaria. Two women and five younger children had died. The family were entirely dependent on the casual earnings of the man as a labourer and the eldest boy as a cow-herd. On the day that they were visited there was no food in the house and the only resources possessed by the father were two annas that he earned the previous day.

Instances of this kind which it would be possible if necessary to multiply indefinitely point to the one conclusion that among communities, such as those to be met with in the villages of Bengal, the prime factor determining a heavy mortality is economic stress.

The people of Bengal in common with all primitive and partially-civilized races are subject to an extraordinary variety of parasitic infestations; and as a natural result, whenever conditions become less favourable to human life, manifestations of disease appear among them. And epidemic manifestations of cholera, malaria and dysentery are among the phenomena which recur with a regularity as unfailing as the change of the seasons.

The most healthy portions of the year are those periods in which the population is exposed to least change and least exertion—February and July and August. The one period occurs in the middle of dry weather, when the days are fairly cool and the nights are mild; the other period occurs in the middle of the rainy season, after the rains have become well-established. It is at the transition periods; the season when the dry weather is coming to an end and the early rains are expected; and the season when the rains are ceasing and the dry weather is approaching that serious manifestations of disease almost invariably appear. At these times of change, cholera or dysentery appears in the areas subject to the annually recurring inundations, and malaria in those that are above the reach of inundation.

An examination of the conditions under which the population lives affords an explanation of the manner in which they die.

In the areas subject to flooding there are many large and active rivers and hundreds of intersecting *khals* and at the time of inundation the whole country is almost submerged. The population of these areas invariably depend upon river and *khal* water for every purpose. In the time of flood, the river water is at their doors, but in the dry weather it recedes. And not only do they drink from this common source, but they bathe in it, wash their clothes in it and attend to every call of nature at its edge. Thus they are exposed to the attacks of every form of parasitic organism which spreads from man to man through the medium of a common water-supply. But in the areas above the reach of floods, which are usually not well supplied with streams of running water, conditions are less favourably to the multiplication of water-born human parasites. The population in these localities depends upon tanks and wells for its water and these sources of supply are not exposed to the extraordinary amount of fæcal contamination to which the rivers and streams are subject. On the other hand the malarial parasite is far more prevalent in these situations than in the areas subject to inundation. For jungle is usually more dense, waste land pitted with hollows is common and where collections of water exist they are usually of a suitable nature for the breeding of anopheles.

Ordinarily however the inhabitants of these different areas are largely tolerant of the respective parasites to the attack of which they are all of them from time to time exposed; and disease occurs only among the least resistant of them. But at times of economic stress a large number succumb to their parasites and a vicious cycle comes into action. Conditions become unfavourable to human life, and the powers of resistance of the population are reduced below the normal level; and this circumstance is favourable to the rapid multiplication of human parasites, with the result that disease becomes widespread. And with the occurrence of disease privation is intensified, and leads on to a still further multiplication of parasites, more disease and more privation.

Malaria.—Malarial infection is universally met with in Bengal, but the "static malaria" of different communities varies very greatly, according as circumstances are favourable or not to the spread of the parasite. In areas subject to annual flooding by rivers it is usually very low, whereas in places above flood level it is generally comparatively high. The spleen and parasitic indices of villages situated on live rivers and *bheels* are usually lower than those of villages on dead rivers and stagnating *jheels* and *bheels*. Villages situated in comparatively open country, and surrounded almost entirely with cultivation whether fairly free of jungle or not show less evidence of malarial infection than those surrounded with waste land and hidden in jungle.

The type of parasite most usually met with south of the Ganges is the B. tertian, but the M. tertian is also very common. Quartan appears to be rare. The commonest malaria carrying-anopheles is N. *fuliginosus*, which is very widely distributed over Bengal. It is found almost everywhere irrespective of whether there is much evidence of malarial infection. Its larvæ are readily found in the weed-covered water of moribund rivers, around the edges of stagnant *bheels* in neglected tanks, large pools, borrow-pits and smaller collections of water, provided weed is present. They are not usually found in running streams or along the edges of large rivers, neither are they readily met with in the water of active bheels.

In the districts in which depopulated areas are most commonly seen, Jessore, Nadia, Mushidabad, Faridpur and Rajshashi the spleen index is generally very high. Stewart and Proctor who examined 190 villages situated in the three former districts during the Bengal Drainage Commission, found an average spleen index of 59 *per cent.* More recently Fry has confirmed the view that these districts generally present evidence of a very high incidence of malaria. In Faridpur district the incidence of malaria is less uniform. Depopulation is going on in the north-west of this district, and there the spleen index is high, but in the south the incidence of malaria is much reduced.

The observations which point to an invariable association of a high incidence of malaria with a condition of gradual depopulation have naturally led to the conclusion that an intensification of malaria has increased the mortality and so brought about a reduction in the population. But there are reasons for believing that this view does not really represent the course of events.

Depopulation leads to the abandonment of cultivation about a village, the increasing growth of jungle, and the greater neglect of tanks; and so tends to bring about a condition of things more and more favourable to malaria, and the increasing poverty of communities undergoing loss of population has also a marked influence in assisting to bring about an increase of malarial infection.

On theoretical grounds too there are reasons for supposing that the process of depopulation itself may tend to increase the incidence of malarial infection. In recent years there has been a good deal of attention directed to the mathematics of malaria and the names of Ross, Waite and McKendrick are well known in this connexion. These workers have endeavoured to prove that the incidence of malarial infection among a given population is dependent upon the relative density of anopheline carriers of malaria. Thus assuming a fixed human population in a certain area the presence of a given number of anopheles mosquitoes evenly distributed over that area would result in a definite number of collisions between the units of the human population on the one hand and the units of the anopheline population on the other. The introduction of the malaria parasite under these conditions would result in a gradual

spread of infection until a definite "static level" of infection was reached proportionate to the number of collisions taking place. An increased relative density of anopheles would increase the number of collisions and raise the "static level" of infection; a reduction of anopheles would reduce the number of collisions and lower it. Similarly an increase or decrease of the human population under these conditions would increase or decrease the number of collisions between the units of the human and anopheline populations, and would bring about an ultimate rise or fall in the "static malaria level." But this conception ignores the possibility of selection on the part of anopheles, and the probability that man attracts these insects. And if we assume that such factors are present, the problem is completely altered. In these circumstances the reduction of a human population instead of tending to reduce the spread of the malarial parasite would tend to increase the chances of infection amongst the remaining inhabitants.

At the present time however, although a few observations have been recorded which point to mosquitoes being attracted to man, the subject has not been systematically investigated; and it would appear to offer a fruitful field of enquiry.

Conclusions.—Having taken a brief glance at a number of the factors which together form the environment of village communities in Bengal and noted some of the important changes which may be produced in that environment from time to time, we are now in a better position to discuss the problems connected with the phenomenon described in the opening paragraphs of this paper, the depopulation of certain areas, co-incident with an intensification of malaria.

We have seen that Bengal owing to its intimate relation with the Ganges, of which it forms the delta, contains certain areas which are of older formation than others. In the natural course of events the relation of the main river and the great subsidiary channels which take origin from it to these older portions of the delta must undergo a change; resulting in a gradual receding of the water, and an apparent rising of the land; the cessation of the annually recurring inundations; the rapid silting up of the rivers and khals; and the eventual closing of communication between these rivers and khals and the Ganges, followed by their final stagnation and death.

Co-incidently with these changes the surface of the country undergoes a corresponding modification. Fertile plains once mainly composed of rich *bila* land, gradually become converted into areas in which poorer *dangi* soil predominates; and localities at one time capable of supporting an extraordinarily dense population under the existing system of primitive cultivation often fail to supply the wants of a greatly reduced number of inhabitants.

Meanwhile other factors come into play. The loss of fertility resulting from the cessation of the annual floods of silt-bearing river water is gradually intensified by the planting of the soil with exhausting crops of jute. Under the stimulus of high prices and the pressure of diminishing harvests the cultivator is tempted to rely more and more upon jute and less upon other crops; and so the impoverishment of the soil goes on to an increasing extent, until at last the land yields so little that it no longer pays to work it. When this happens the population is helpless; for they have been accustomed for generations to reap enormous harvests in return for the expenditure of little effort, and are therefore unused to any but the most primitive methods of agriculture. Thus from a condition of prosperity they are gradually reduced to a state of destitution. And when a community accustomed to ease and plenty is reduced to poverty and destitution there can be only one result, increased mortality, increased migration, reduced birth-rate and a rapid dwindling of the population. Meanwhile the villages become more and more deeply buried in jungle, the land around them goes out of cultivation more and more rapidly, the tanks become more broken and neglected; and in proportion as the population is diminished the incidence of malaria increases.

It is possible in these occurrences to trace the working of a whole series of vicious cycles, which once put in operation tend to bring about the decimation and final extinction of a population. Thus the cultivator in an area which is losing its natural fertility, too ignorant to improve his methods of agriculture, and tempted by

the diminishing returns from his land, plants an increasing amount of jute, a crop which fetches a higher price than paddy. But jute exhausts the soil much more rapidly and completely than paddy; and the result is that his harvests continue to diminish. And the more they dwindle the more jute is planted in the hope of equalizing profits, until at last the soil will yield no decent crop of any kind and finally goes out of cultivation.

In the same way, the commencing depopulation of a village introduces another vicious cycle. The loss of population reduces the local demand for labour and for products of every kind thus the labourers, petty traders and craftsmen suffer. Many of them migrate or are reduced to destitution, and this still further reduces the population, and with it the local trade; and this again leads to further depopulation.

The working of another vicious cycle can be traced in the gradual impoverishment of a village community. As the soil becomes exhausted, the number of cultivators is reduced by death, migration and destitution, occasioning loss or ruin among the landholding classes. First the *dorjotedars* suffer, then the *jotedars* and *talukdars*, and finally the *zamindar*. And this impoverishment of the small gentry of a village forces them to reduce their establishments and diminish their expenditure, so that they can no longer afford to make gifts to brahmins and beggars. Meanwhile the increasing poverty increases the population dependent upon charity and at the same time reduces the resources of the charitable. And as destitution increases, the health of the community deteriorates. Finally the increasing ill-health of the village alarms the people, and those who can afford to do so migrate to other places, and the migration of these people diminishes the resources of the remaining inhabitants, increases the number of destitute, and further intensifies the distress.

Similarly the intensification of malarial infection is brought about by another vicious cycle. When once depopulation of a village is in progress, facilities for the breeding of anopheles tend to increase, at the same time the human population is being diminished. As a result the infection of the community increases. And this increase of malarial infection, itself produced as the result of depopulation, and increasing economic stress acting upon a parasite-laden community, tends in the presence of continued economic stress to result in an increasing prevalence of disease. This again leads to a further decrese of population, a further increase of economic stress, a still greater intensification of malaria, more and more disease, and so on, until finally the affected population is wiped out of existence.

As has been already pointed out, in the opening paragraphs of this paper, it has generally been supposed that an increase of malaria, in the special tracts referred to, has caused excessive mortality among the inhabitants, resulting in the gradual depopulation of the areas and the consequent decay of their prosperity. But a consideration of the facts shows that the true sequence of events is, firstly, a decay of prosperity, and then an increase of mortality and migration, resulting in rapid depopulation. And while this process is going on malarial infection increases in intensity with proportionate rapidity.

The prime factor responsible for the depopulation is reduced prosperity; and the cause of this reduced prosperity is the diminished fertility of the soil, upon which the whole population depends for its existence. The main factor responsible for the increase of malaria is the progressive depopulation of an area at one time densely inhabited with a people among whom malarial infection has probably always existed, but perhaps only in comparatively small amount.

The origin of all these associated phenomena; the fundamental cause of the diminishing fertility of the soil; which is the prime factor responsible for the successive decay of prosperity, increased mortality, progressive depopulation, and intensification of malaria; is the change in the relation of the Ganges to the land to which it has given birth. And this change is part of a natural process to the action of which every portion of the delta must sooner or later be exposed.

An appreciation of this fact will show that we must expect to see the occurrence of phenomena resembling those described, whenever and wherever factors similar to those whose action we have traced are brought into play. At the present time there are portions of Bengal whose soil is so fertile owing to the enriching inundations to

which it is exposed, that it can support in comparative comfort a population amounting to as many as 2,000 persons per square mile. These are not the areas that have been recently formed, for in the latter the population has not yet had time to expand, but they are the areas in which changes are most likely to occur in the future. At present in spite of their enormously dense population they are comparatively healthy; and although malarial infection exists among the people, and anopheles mosquitoes occur, sometimes in comparatively large numbers, the infection is neither very prevalent nor is it often associated with much serious disease But should similar changes to those that have already occurred in older parts of the delta take place there, we may expect to see the population eventually reduced to a third or a quarter of what it is at present; and a gradual intensification of malarial infection will follow as a natural result. And in proportion as different localities lose more or less of their inhabitants, the final incidence of malarial infection will be found to vary in more or less close relation to this fact.

A consideration of the facts dealt with in the preceding pages shows that the increase of malaria in Bengal associated with depopulation of certain areas is not due, as has sometimes been supposed, to water logging of the soil. It takes place in areas which are now much higher above water level than they used to be; and the stagnating bheels and rivers present are only the remains of very much larger collections of water that once existed there. Neither has the stagnation of these rivers and bheels been the most potent cause of the trouble, although it has assisted no doubt in rendering conditions more suitable for malaria. It is not the lack of current in the rivers and the absence of rapid flow in and out of bheels which is so important, as the fact that the water no longer contains a rich supply of silt and no longer overflows the neighbouring lands and enriches them. The idea that railways and roads were responsible for the trouble also appears to have no foundation. Their existence in areas which tend to become malarious is largely an accidental matter; and though their presence may have assisted to increase malaria in some small degree, the intensification of the infection would have gone on even if they had never been constructed. The steeping of jute appears to have had no influence upon the spread of malaria. Moreover, it is quite possible that it has really been unfavourable to the infection, because water in which much jute has been steeped, although frequently swarming with the larvæ of mosquitoes of the genera Mansonia and Culex, does not usually harbour those of dangerous anophelines. On the other hand the growth of jute on areas no longer being enriched with silt-laden river water has been a potent factor in bringing about a condition of depopulation, because of the rapid impoverishment of the soil which results; and the growth of jute therefore may be said to have indirectly helped to bring about the intensification of malarial infection, in many communities undergoing depopulation. The overgrowth of jungle in the villages is accidentally associated with the condition, because it is largely dependent upon depopulation, as was pointed out by Buchanan one hundred years ago. In the Sunderbund area of Bengal where there is dense jungle malarial infection is usually almost absent.

In the light thus shed upon some of the most serious problems of Bengal malaria, the measures that have been suggested from time to time as a remedy for the evil no longer appear adequate.

The dredging of open channels connected with the Ganges, which may be in danger of silting up, can only postpone the occurrence of the trouble in parts of the country as yet unaffected; and the attempt to resuscitate rivers that are already moribund cannot remedy existing conditions and may even precipitate their occurrence in areas at present free.

Huge drainage schemes designed to deal with the supposed water-logging of the country are also likely to prove futile; for they cannot possibly influence the cause of the trouble. Similarly the cutting of jungle cannot be expected to produce a very marked result; for the excessive growth of jungle is only an accidental condition associated with the abandonment of once cultivated land and the depopulation of village communities.

The measures likely to prove most successful in producing an amelioration of conditions already in existence are those directed to an improvement in the circumstances of the affected communities by an advancement in their methods of agriculture.

They have been reduced from a condition of past prosperity to one of present poverty by changes which might have been foreseen but could not well be prevented. But though we cannot restore the natural process of soil fertilization, the annual inundations of silt laden water, to which the land in the affected areas was once exposed, and upon which its former prosperity depended, it is within our power by improved methods of agriculture, careful manuring, seed selection, rotation of crops and other measures to neutralize the effect of diminished natural fertility, and bring about a condition of prosperity as great or even greater than that previously existing. Hence every effort should be concentrated upon furthering improvements in agriculture; and these efforts must include a larger measure of general as well as special education, the increase of agricultural farms, the extension of co-operative credit banks, and the organisation of practical demonstrations of improved methods in every locality. It will also be necessary to direct attention to existing systems of land tenure so as to ensure that the gradual process of improvement is not checked by any artificial restrictions.

No very rapid improvement must be expected at first and it may take several generations before the effect becomes apparent; but sooner or later it will come about; and those at present living may yet see commencing recultivation and repopulation of areas once densely inhabited but now given over to jungle. And as this takes place, malaria will diminish to a corresponding extent until it finally disappears even from the places which are at present most seriously affected.

It has already been pointed out that there is reason to suppose that similar changes to those which have taken place in the older parts of Bengal will tend to occur in other areas. It is possible however that by taking due precautions, these changes may be postponed though it is doubtful if they can be altogether prevented. For this purpose the periodical dredging of existing large open channels, and the application of methods of water conservancy to smaller streams and khals appears to offer some hope of success.

But side by side with these measures, the education of the people must be pressed forward, so that in the event of failure, they may be able and ready to neutralize the results of the disaster, as soon as it occurs.

NOTES ON ANOPHELINE DISTRIBUTION IN THE UNITED PROVINCES

By Major J. D. Graham, I.M.S., Special Malaria Officer, United Provinces.

After the visitation of epidemic malaria in 1908, the Local Government in November of that year appointed two whole-time Indian Medical Service officers for purposes of malarial research, and since 30th April 1909 one officer has remained on special duty for this purpose. As a result of four years of work, a large number of accurate observations in different areas of the provinces have been made, and I propose to give a brief resumé of these in so far as they affect the distribution of anophelines.

Prior to 1908, except for the work of Giles, little that was accurate was known in regard to the species of mosquitoes normally present throughout the provinces, their relative prevalence, distribution, and seasonal variations; and, as the only road towards completeness and accuracy is by a careful record of accumulated reliable observations, the gaps at this stage in the enquiry must be disappointingly frequent, though most of them will, in time, be completed.

With a province which extends from north-west to south-east for over 580 miles and from north to south for nearly 500 miles, touching the Punjab, Tibet, Nepal, Behar, Central India and the Central Provinces, considerable variations in distribution would naturally be expected, while the delimitation of the provinces physiographically into a Himalayan area of mountains and Terai, a submontane region along the hills south of the Terai, and a riverain or doab region, and economically into a western or highly canal irrigated and an eastern or highly well-irrigated area would be expected to show a merging of the variations into those existing in the Southern Punjab and Upper Behar. In the accompanying map the Himalayan area is in green, the submontane in yellow, the doab or riverain in pink and the central area and Bundelkhand uncoloured.

The fauna of the Upper Himalayan region is sharply demarcated from that of the riverain, while the Terai portion of the Himalayan, and the submontane areas show various degrees of gradation from the one to the other. As so much of the investigations of the special officer have, during 1909–1910, 1911 and 1912, been confined to special places, the observations have gained in their accuracy, completeness, and continuity what they have lost owing to paucity of localities.

Briefly, in the Upper Himalayan region we have observed at Almorah, Ranikhet, Naini Tal, Bhowali, Dharmote and Kalighat, and culicifacies, fuliginosus, listoni, willmori, willmori (variety maculosa), maculipalpis, lindesayi, and P. simlensis have been found.

In the Terai region of the Himalayan area we have made observations in several places in the Dehra Dun, throughout the whole length of the Naini Tal, Terai and Bhabar from Kashipur to the Nepal border and from Kathgodam to Kichha and have found rossi; culicifacies, fuliginosus, listoni, maculipalpis, maculatus stephensi and nigerrimus.

In the submontane region at Saharanpur, Nagina, Moradabad, Bareilly, Pilibhit; Gonda, Basti, and Gorakhpur we have found rossi, culicifacies, fuliginosus, listoni, maculipalpis, stephensi, nigerrimus, barbirostris, pulcherrima and P. simlensis.

In the doab region of the Ganges, Jumna, Gomtee and Sarda rivers we have made observations in Kairana (district Muzaffarnagar), Meerut city, Kosi (district Muttra), Muttra, Etawah, Fatehgarh, Cawnpore, Allahabad, Fyzabad and Adjodhia, and a very large number of places in Ghazipur and Ballia districts, and have found rossi, culicifacies, fuliginosus, maculipalpis, maculatus, nigerrimus, barbirostris, stephensi, pulcherrima. Lastly in the central area and Bundelkhand, we have observed in Rae Bareli, Lucknow, Hamirpur, finding rossi, culicifacies, fuliginosus, stephensi Bundelkhund, however, requires a large amount of further observation as it is a very large area, in parts sparsely inhabited, and its fauna would be expected to merge into that of the Upper Central Provinces.

A tabular statement shows that culicifacies and fuliginosus are universal, rossi not being found in the mountains but appearing in the Terai area, and being present in abundance everywhere else. The mountains give us willmori and lindesayi which are found nowhere else, while they are destitute of stephensi, nigerrimus, barbirostris, pulcherrima and maculatus, the two first appearing in the Terai and continuing throughout the other areas, while barbirostris, pulcherrima, appear in the submontane, persist in the doab, but are not found in the central areas or Bundelkhund.

Maculipalpis is not found in the mountains, appears in the Terai and diminishes towards the doab.

Maculatus appears in the Terai and is noted as appearing in the doab, but this observations has not been confirmed by me nor have I seen the specimens.

Tabular Statement.

Name of Mosquitoes.	Himalayan (Mountains).	Himalayan Terai.	Submontane.	Doab or riverain.	Central and Bundelkhund.
Ny. M. rossi	..	+	+	+	+
M. Culicifacies	+	+	+	+	+
Ny. Fuliginosus	+	+	+	+	+
M. Listoni	+	+	+	..	..
Ny. Maculipalpis	..	+	+	+	..
Ny. Maculatus	..	+	..	+	..
Nes. Willmori	+	..	..	..	..
Nes. Willmori var maculosa	+	..	..	..	..
P. Lindesayi	+	.	..	..	..
Nes. Stephensi	..	+	+	+	+
My. Nigerrimus	..	+	+	+	+
My. Barbirostris	..	..	+	+	..
C. Pulcherrima	..	..	+	+	..
P. Simlensis	+	..	+	..	..

Ny M. rossi—is the most abundant of all. Its absence in the Himalayan area is what would be expected from its general habits which have been found much as described by previous writers. Its role in regard to malaria is still obscure, though nowhere in spite of repeated dissection has it ever been found to be carrying. Its seasonal distribution corresponds with the malarial season, however, in Meerut and Kosi, and it appeared after the onset of the rains, reached its maximum intensity in the rains, diminished, and generally disappeared about November, December, never being found in quantity again till the succeeding rains. It bids fair to behave similarly in the eastern doab now under investigation. Adults were not found to persist throughout the cold weather of the Western United Provinces.

M. culicifacies—is probably the most universally distributed of all. There is little fresh information to add to what we know of the favourite haunts and selectivity of this well-known carrier. It was bred from the lake water at Naini in June 1911, but has been found nowhere else in the hills. It occurs in fair quantity in the Terai and Doon; but reaches its maximum in the submontane and doab areas. The rice fields of Saharanpur, Nagina, Basti, Gorakhpur, Ballia and Ghazipur, the river and tanks of Gonda, the river at Balrampur, tanks at Kairana, the Delhi-Agra canal at Kosi, the Abu Nala at Meerut, and Gomtee at Lucknow were all producing this in varying quantity during the rains while in the wells at Kasia, Deoria, Barhaj, Salempur and Captainganj in the Gorakhpur district larvæ were found in considerable quantities rather an unusual breeding place in my experience for this mosquito and one which I have not seen mentioned before. Its relative prevalence increased throughout the rains till about mid October when it gradually decreased. In Meerut city we were able to breed out specimens in January while a few adults could be found there all the year round. In Kosi in 1910–1911 only an odd adult female was found at the time of arrival in early July, but as the pools in the empty canal bed formed simultaneously owing to the closing of the canal, the larvæ were seen developing and in two weeks the canal bungalow and town alongside swarmed with adults. No increase was apparent during the hot months of May and June. Its selectivity is great, and it will not breed in quantity in borrow pits when plenty of clean water is about as in the canal.

Ny. fuliginosus—runs culicifacies closely for universality of distribution and probably beats it in numerical prevalence. The fact pointed out by Christophers, James and Stephens that this mosquito seems independent to a great extent of the monsoon rainfall, was repeatedly demonstrated. It persists all through the cold weather and in the western United Provinces the larvæ remain small and in places seem to hibernate and refuse to develop. In Meerut we were able to breed out an occasional odd one all through the winter. In March and April in the western United Provinces it is by far the commonest anopheline near inhabited areas, and at the beginning of the rains is usually in excess of any other until rossi and culicifacies overwhelm it. I think its period of greatest increase in the western United Provinces is towards the end of the rains, *i.e.*, October and in the eastern United Provinces this promises to be the case too.

It was bred from Naini Tal lake water in June 1911 and 81 adults were caught in the bazar there while a female was caught at 7,000 feet. It was found in the Terai during the six months, November to April, and throughout the sub-montane area from Saharanpur to Gorakhpur, the doab and the central area. The variety "adei" was found at Meerut.

M. listoni—is essentially a hill, Terai or sub-montane species. Its breeding grounds have invariably been of the unusually described type. It was bred from Naini Tal lake water and adults were found in Naini Tal bazar, at Bhawali and various places in the Terai, and Doon by Robertson and myself. In November 1911 I found at the edge of the Sal jungle 5 miles from the exit of the Sarda from the hills, a small stream producing hundreds of this species only. The adjoining "got" or Pahari village some distance off and used only in the cold weather had numerous adults which must have had considerable powers of flight judging by the distance of the village from the main breeding ground.

It was got at Saharanpur by Robertson but not at Nagina and has been reported from Cawnpore though this has not been verified by me. The merging of the characteristics of some specimens into those of culicifacies was noticed.

Ny. maculipalpis.—Absent from the high hills, was found at various places throughout the Terai and in November 1911 was the commonest mosquito at Tannakpur near the Nepal border where the Sarda emerges from the hills and within 5 miles of the stream already mentioned as producing listoni only. It was found in 1909, 1910, 1911 in both Nagina and Saharanpur, in 1910 in Kairana a stray specimen was got, but no where else have I observed it. Kichha in 1910 produced large numbers and Major Robertson incriminated it as a carrier.

Ny. maculatus was bred from the lake at Naini Tal and 52 adults were found in the bazar there. It was found in the Doon and at various places in the Terai, and in 1909 Wyville Thomson reports it at Dehra. This correspondence with its known prevalence in the Bengal Doars. It was never present in large numbers

Neo Willmori and *P. lindesayi* are essentially hill mosquitoes. Both were found in Naini Tal and the former was bred from the lake water. The variety "Maculosa" was recognised at Naini Tal. Major Cochrane sent me a single specimen from Bhawali Consumptive Sanatorium which proved to be a female Willmori, while Almorah, Ranikhet, Bhawali, Dharmoti in Kumaon (all above 4,000 feet) have supplied specimens of lindesayi. They breed in mountain streams, flourish between 3,000 and 7,000 feet and seem to cease where much sand begins to appear in the river bed. Willmori was found at Almorah by Lieutenant-Colonel Hehir.

Neo Stephensi.—Absent in the hills, appears in all the other areas, and is most numerous in the doab. It was found in the Naini Tal Terai, at Bareilly, Kairana, Kosi, Lucknow, Fatehgarh Rai Bareli, Ghazipur, Fyzabad, Ajodhia, Allahabad and Cawnpore. It was almost invariably found breeding in wells as in Bombay and in Lucknow was present in considerable numbers in the wells near the Gomtee and Medical College, being present in several of the wells in the compounds of the professor's houses. In Kosi it was confined almost entirely to partially used wells (not disused wells as in Madras). The well species is smaller than that found in pools as noted by Bentley. It was found, though rarely, in early May in Lucknow, and was most numerous there in October. One single well specimen was forwarded to me from Rai Bareli by Major Walker in 1910.

My Nigerrimus and my barbirostris.—The former was found in the Terai though scarce, and increased in the sub-montane area and diminished again in the doab; the latter was most numerous in the sub-montane area. Both were obtained at Nagina, Saharanpur, Bareilly, Gorakhpur, Gonda Meerut, Bilthra and Korantadih in Ballia district, while the former was got in the Doon, at Balrampur, Kairana, Etawah, Cawnpore, and Reoti in Ballia. In most instances very few larvæ were found together—a frequent observation—but Gonda was an exception as here the river and Kachha and pucca tanks held large quantities.

Other species—C. Pulcherrima was found, in small numbers only, towards the end of the rains at Nagina, Kairana, Kosi; but nowhere in the province was there any approach to the situation. Perry describes as prevailing at Dera Ismail Khan and in the western Punjab. The adults at Kairana appear to live through the winter.

P. simlensis was found at Kali ghat Garhwal (6,000 feet) by Dr. Imms (*vide* James and Liston, page 69) and at Bareilly, the latter not being verified by me.

These species are however to be considered more as interesting occurrences in the United Provinces. Had they been present in larger numbers they would certainly have been noted oftener.

The influence of a series of mild malarial years since the epidemic year of 1908 may have gone "pari passu" with a qualitative and quantitative alteration in the species, which it is difficult to estimate. Be this as it may, the fact that the more common species have observed a similar sequence in different localities far apart would indicate that there is considerable regularity in the laws governing their bionomics, which only extended observations over a series of years in a few fixed localities are likely to unravel. It would further indicate our surest line of approach to this very difficult subject along the pathway of extended systematic observations in marked localities over successive years and their accurate record.

ON SOME POINTS IN RELATION TO THE BREEDING OF MOSQUITOES.

By Rai K. C. Bose Bahadur, C.I.E.

Stray notes on the breeding of mosquitoes by one who has no pretension to understand the technique of the process, and who has never spent an hour in acquiring knowledge of entomology will, I humbly trust, be not altogether uninteresting to those who have made the subject a special branch of their study and scientific research. Actuated by a desire to understand the various stages in the life cycle of mosquitoes without regard to their species, I collected a few vessels of various dimensions and depths and after having filled them with filtered water placed them in different parts of the house and under different environment. It may be mentioned that amongst the vessels specially selected for the purpose I had glass bowls and jars, earthen *hundies*, brass *thalies* and tin canisters. The vessels which were placed in dark room when brought out in light after twelve hours showed deposit of eggs on their surfaces, whilst those kept under powerful electric light had none within the first 24 hours. The first series of experiment began on the 12th June and lasted till the end of the month. The second series was taken in hand by the 15th of August and lasted till the 10th September 1911. The third series was commenced in the beginning of October and carried till the 4th November 1912. The experiments did not require any peculiar tact, although they were done with the greatest care and attention. The vessels as a rule were placed in their respective places between 8 and 9 P.M. and were examined during the following noon. Of the three earthen pots used for breeding mosquitoes two were new and one was old. On the following day ova were found floating on the surface of the water placed in the old pot. In the new pots it took four clear days to attract mosquitoes to lay their eggs. They were placed in a room where no light was placed. Of the three brass utensils one was placed in a room in the third flat of the house 40 feet above the level of the street. There was light in the room; the second was placed under the stairs, the third on the ground floor in the shade caused by a group of plants kept in pots; on the third day they were brought out for examination. In the one which was placed amidst the plants on the ground floor larvæ were found wriggling. In the rest the eggs were found floating. Of the three glass bowls one was placed on a mirror laid flat on a table in a room which was well lighted and had openings on all sides; the other two were placed in different parts of the same room. The one which was placed over the mirror was not courted by mosquitoes and no eggs were lain in it within the first ten days. On the 11th day the mirror was removed and on the 13th day ova were found floating on its surface. In the two other bowls the ova were found on the third day. The tin canister was placed on the terrace of the house; it was not examined for two days; on the third day larvæ in good number were found wriggling on the surface of the water. The larvæ of the first series of experiment took four days to convert themselves into pupa and the pupa full three days to become mosquitoes. The procedure observed in the second and third series of experiment was almost the same as that adopted in the first with slight variation in the treatment of water. Four sorts of water were selected for charging the vessels—the sterilized water, tepid water, cold water and unfiltered water. There was no marked difference in the result and the growth and development of the larvæ was not in any way interfered with. In the third series only tap water was used, but the procedure was altered which requires mention. In vessel No. 1 water was saturated with sugar. In No. 2 it was slightly mixed with syrup. In No. 3 it was kept plain. In No. 4 a little salt was used. In No. 5 a piece of boiled fish was placed. In Nos. 6 and 7 leaves of *Adhatoda vasica* green and dried were used. The vessels were kept in their respective places in the evening of Friday the 4th of October last. On the following noon ova were found in vessels Nos. 3 and 5. The rest were free. Two mosquitoes came out of vessel No. 4. On Tuesday morning larvæ were discovered in all the vessels excepting the vessel No. 1 in which the water was saturated with sugar. It may be mentioned that no larva was ever detected in this vessel. I do not know whether there were any eggs in it or they did not hatch. In vessel No. 7 in which dried leaves of *Adhatoda* were used the growth of larvæ was stunted and they died before they could reach the pupal stage. In

vessel No. 6 in which green leaves were placed no deleterious action was found on the growth of the larvæ. In vessel No. 5 the larvæ thrived very well, and the duration of the larval stage was reduced to 4 days and the pupal stage lasted only for 48 hours. Similar results have been obtained from experiments conducted by my young friend Dr. J. K. Mitter, a rising medical practitioner of Calcutta practising in the district of Burra Bazar. He found by most careful observation that the pupal stage did not last longer than two days.

In describing the various stages of a mosquito life I have mainly depended upon the results of my own experiments which, I must candidly confess, were carried on in a crude state. In the majority of cases the ova resembled very much the smallest variety of poppy seeds. They were brownish, red, or pinkish white; they were round like dots, but when examined by glass they were found to be elongated. They were found in elongated clusters and would float in clusters, and when separated by agitating the water they would soon coalesce and assume the same form in which they existed before separation. Their vitality is not destroyed by constant movement of water. The eggs hatch in some cases on the third day, but in the majority of instances the process was delayed to three full days. The duration of larval stage is from three to five days. The larvæ are voracious. In the vessel in which a piece of boiled fish was placed the larvæ thrived admirably well and they completed this stage of their existence in 3 days whilst in vessels in which no food stuff was put they did not reach their pupal stage until the fifth day. The pupal stage does not under any circumstance last longer than three days, but under favourable circumstances it is completed within 48 hours. The pupa requires no food. The transition from the pupal stage to the stage of perfection is attended with certain amount of risk. The Pupæ that become impatient to extricate themselves from their imprisonment within a vessel encounter danger to their life. Their premature attempt to use the wings leads to their destruction. The wings get wet and do not expand; the baby mosquito struggles hard to get out of the difficulty, but its power is soon exhausted and is readily carried into the bottom where it soon dies and is preyed upon by the larvæ, whilst those that are cautious easily tide over the difficulty. They slowly leave the surface of the water, sit upon the walls and then upon the edges of the vessels and then launch into the world to discharge their functions as carriers of malaria and thus become enemies to man. From close and careful observations of the breeding process it has been found that the best time for laying eggs is between midnight and dawn. The larvæ, however active or thriving they may be, are readily killed by kerosine oil. I have often tried this. I can emphatically say that in larvæ-cidal property kerosine oil excels all other products of the petrol group. I do not know whether the mosquitoes are provided with any special apparatus through which they could hear sounds but circumstances tend to prove that they are not absolutely void of the sense of hearing. When swarms of mosquitoes are found in open place especially during the approach of evening, boys attract them by simulating their hum and thus kill a lot of them. That the mosquitoes possess the sense of smell is demonstrated by the fact of their resenting strong smell of phenol; camphor; and other chemicals. The environment of Calcutta is very favourable to the propagation of their species. Any excavation with little accumulation of water is capable of breeding mosquitoes and the number of such excavation even on the sides of the well-paved street is not small. The gully pits when clogged convert themselves into receptacles to breed these infernal insects. You would be surprised to find that the tracks of cart wheels are made favourite places for the breeding of mosquitoes. I fear I am encroaching upon your time. I would therefore proceed no further. My acknowledgments are due to Mr. B. L. Chowdhury, B.A., B.Sc., F.R.S.E., who materially helped me in conducting the experiment.

NOTE OF AN INQUIRY INTO MALARIA AND MOSQUITOES IN THE KASHMIR VALLEY.

By Lt.-Col. and Mrs. Adie.

In a recent visit to Kashmir, we took the opportunity of inquiring what was the condition of malaria and anophelines in Srinagar and its neighbourhood. We were kindly informed by the profession that, practically speaking, there was no malaria here and no anophelines, and that the cases of malaria, which were met with generally about July, August and September or so, were imported from down-country.

We are not aware of a systematic malaria survey has ever been made in Kashmir, and we therefore took a keen interest in conditions which were new to us. As the work has all been done by ourselves, without any staff, it does not claim to be complete, but it may be considered in the nature of reconnaissance.

Our observations extend from the latter part of April to the end of October of the present year, and include the city of Srinagar, its suburks, and the tract of country where the Sind River leaves the Sind Valley and begins to spread out into several channels (Ganderbal)—an area of about 20 miles by 10.

We may state at once that we can sum up our observations in one word—negative; for we have not yet met with a case of malaria originating in these parts, and we have captured two adult anophelines and four larvæ.

General remarks.—Srinagar lies nearly in the middle of the Kashmir Valley, which runs south-east to north-west, and is about 84 miles long and 25 wide, and has an average altitude of 6,000 feet. It is drained by the River Jhelum. The valley lies in a hollow of a complex of mountains reaching from the Punjab plains to the Himalayan giants of the North, Nanga Parbat, 26,900 feet, etc.

At Srinagar the average temperature, put shortly, is as follows :—

Mean—January	..	..	..	..	..	33·2	; diurnal	range 14·2
May	..	..	..	..	..	63·9	„	„ 24·0
July	..	..	..	..	..	74·3	„	„ 20·8
November	..	..	..	..	..	46·4	„	„ 28·1

The average rainfall is 27·24 inches in the year.

The actual rainfall for the last eleven years is as follows :—

22, 36, 33, 26, 26, 29, 34, 31, 23, 28, 19 (1912 to September 30).

Taking a year at random, the following shows rainfall by months in 1909 :—

January	..	..	2·7	July	..	..	6·48	14·37
February	..	..	3·46	August	..	..	·77	
March	..	..	3·56	September	..	..	7·12	
April	..	..	1·53	October	..	..	1·65	
May	..	..	1·97	November	..	..	*Nil.*	
June	..	..	1·04	December	..	..	1·20	

July, August and September accounted for half the total. The principal grain is rice, and it is cultivated up to an altitude of 7,000 feet. Maize is next in importance. As to the general appearance of the adult inhabitants, of whom three-fourths are Muhammadans, they seem well-nourished and robust, but we have often been stuck (in film taking) with the poor physique and timid faces of young boys compared with the plumpness and viracity of young girls. We noticed how well the Mangi class, at least, did themselves as regards food—fowls, ducks, geese, fish, vegetables, etc., being ordinary fare. None says "It may be asserted that the Kashmiri peasantry with their little vegetable gardens, their poultry and sheep, with their abundant fruit trees, with vast mountain grazing grounds, and privileges in the way of firewood and forage, are now exceeding well off." This point is dwelt upon as bearing on the incidence of malaria in a community; the better fed, the better the resistance to epidemic diseases like malaria.

Prevalence of Malaria.—As to prevalence we have decided to confine our attention to the spoken opinion of the profession now practising in Srinagar, and not to burden this report with statistics. Their opinion is given in the opening paragraph. Dr. A. Neve adds, it is such a matter of altitude ; the lower you go the more the malaria. Thus, Uri and Domel have some malaria punch, a good deal lower in altitude, has more; and so on. Endemic Index.—We at once began to examine blood films of children under 12 years. Most of them were under 8.

They were children belonging to houses situated round about the Chenar Bagh (map of Srinagar) on both sides of the apple-tree canal. They belonged largely to the class of watermen ; a few to the cultivator class.

In 101 children examined between 10th and 20th May no parasites were found.

We returned to Srinagar on August 23rd, and between that date and 15th September examined 79 films of children round about the Sonwar Bagh, belonging mostly to the village Ekrajpura. Parents' occupation—cultivators chiefly. No parasite was found.

Among 180 children, therefore, the endemic index was *nil*. So much for children. In the Jail we visited cases which might have been malarial. Prophylactic quinine is issued on the Punjab Lines, and cases of fever were at once treated with quinine.

August 29, 1912—Jail—Examined seven cases of fever, all getting quinine.—

No. 1. Pure Kashmiri: 100·2° negative for parasites.
No. 2. Kashmiri has been to Domel, 99·8°; negative.
No. 3. „ „ 99·8°; „
No. 4. „ „ 99·0°. Greatly enlarged spleen reaching umbilicus ; Crescents found 2 in. 5 min.
No. 5. Pure Kashmiri, 102·4°; Spleen enlarged. Negative.
No. 6. „ 100·8°; negative.
No. 7. „ 101°; „

September 3, 1912.—Examined 7 more cases of similar nature but who had not had quinine treatment but possibly prophylactic quinine—Negative.

September 4, 1912.—Examined 4 more cases of similar nature—Negative.

Thus, of 18 adults complaining of fever in hospital, only one had parasites, and he was a man who dwelt in Domel, and so a lowlander. It must be remembered, however, that several of the above had had quinine.

In the Mission hospital on 17th September there were three cases of malaria applying for treatment, and had not yet had quinine. Malaria was quite uncommon at this hospital at that time.

No. 1. Kashmiri—Had been to the Delhi Durbar ; had fever there ; never any attack before Delhi ; since return has had several ; no spleen ; dyspeptic young man. Film crammed with Benign Tertian parasites (rings and bizarre).

No. 2. Native of Drang near Jummoo: age 23 ; fever for two years anemic; enormous spleen reaching right iliac fossa. Parasites present, few in number, one crescent and one ring in five min.

No. 3 Inhabitant of Srinagar ; been lately with his master to Karma (lowlands); this is first attack ; started ten days ago Film full of parasites (malignant tertian rings).

In the State hospital, we were kindly shown imported cases with parasites (gametes).

The opinion locally held is thus quite borne out by blood examinations, namely, that there is no evidence of endemic malaria in Srinagar, and that cases of the disease met with in that city are those contracted in lower altitudes.

Prevalence of anopheline mosquitoes.—For a period of six months from April 24 to October 26 diligent search has been made for both adults and larvæ. The total catch of adult anophelines was two (*A. barianensis*). These were met with in the Nasim Bagh (on the Dal Lake) at the end of June. We were sitting under a chenar tree at about dusk, when we noticed a few rather large flies about us. One was caught in the hand, and another was soon after gently jammed against the arm with the palm. We saw a few others. The two specimens were not badly damaged. We immediately took steps and laid traps to get more, and thoroughly searched the waters, huts, trees and boats round about, but failed to find their whereabouts. The Nasim Bagh is a beautiful collection of huge chenars with the Dal Lake on the east, rice fields on the north and west, and on enormous orchard on the south.

As regards water collections, these consist of —

(1) The river Jhelum and its puddles.

(2) Canals, and their puddles.

(3) The Dal Lake and its various backwaters, and irrigation cuttings.

(4) Wells, and village collections, borrowpits.

The city is supplied with tap water, and there are no leakages bad enough to harbour larvæ.

The Dal Lake is about 5 miles long and 2 wide; it includes a good deal of marsh, and is connected with the city by various canals. Its surface is rich in aquatic plants and animals, and its banks are very commonly excavated into series of long parallel irrigating channels (like attenuated docks) which are frequently covered with lemna and shaded by willows. In the hot weather, one is tempted to say "that stuff must be reeking with larvæ," but he would be disappointed to find fewer here than in less likely looking waters on the banks of the lake.

As to canals, some are mere connections between river and river, or river and lake; but the greater number are for irrigation, and are brought down in the usual way from the Sind river to serve the rice fields. In some few isolated places, irrigation by wells is carried out, the sub-soil water being only about 8 or 10 feet from the surface.

After frequent and extensive examination the only Anopheline Larvæ found were 4 of Neo. Willmori captured in the Sind valley about 4 miles up from Ganderbal on the 24th and 25th August. They were found by the side of a rice-field near the road in a long ditch which was fed by a small fast-flowing road-side channel about 2 feet wide, coming off an irrigating channel. The water in the ditch was almost stationary and clear, and had grassy edges. Diligent and repeated search in the same and neighbouring waters failed to add to our collection. All four larvæ were bred out. It would thus appear that our six anophelines were chance captures.

As to culicines, in late April no larvæ were seen; in early May, a few in borrow-pits along the Baramulla road, and in the European quarter; none in the Dal. In the middle of May they became more numerous, but still none in the Dal, and yet, when on the lake, one was persistently attacked by adults which were eventually found to be breeding in the hamlets on the shores.

In the end of May and June, they were found in the Dal lake. The lake also contained myriads of chironomus, larvæ and adults; in fact, the clouds of flies popularly thought to be mosquitoes in the hot weather were midges.

At Ganderbal during July and August, culicines were found everywhere, and adults were intensely annoying. In the rice fields in the Amchar Marsh in August clouds of adults (chiefly fatigans) were seen hovering about, and one was violently attacked even when flapping a handkerchief. Taeniorhynchus was also met with.

At Shadipore the conditions were the same These regions are notorious for the swarms of culicines in the autumn months Stegomyia was not met with. It thus appears that here is a case of "No anophelines—no malaria", and the malaria that is imported, with sexual parasites in the blood of patients, cannot be spread on account of the absence of the proper host. We have been greatly struck with this condition of things, especially remembering our experience in Kangra and Kulu last

year. These two valleys are rich in anophelines and have a considerable amount of endemic malaria (endemic index about 4). The following table will show the contrast :—

—	Kangra valley.	Kulu valley.	Kashmir valley.
Average height	4,000	5,000	6,000
Chief cultivation	Rice	Rice	Rice
Irrigation	Canals	Canals	Canals
Rainfall	70 in.	35	27
Temperature	68	60	54
Anophelines	Abundant	Abundant	Practical *nil*
Endemic index	4 (approximate)	4 (approximate)	*Nil*
"Malarial season"	Bad	Rathar bad	Very slight
Geographical conditions	(See map 1)	..	..

Map No. 1 shows the arrangement of mountains and rivers with regard to the three valleys and speaks for itself It will be seen at once that the Srinagar valley is separated from the plains by about 100 miles and is surrounded by a maze of lofty mountains, while the Kangra and Kulu valleys are not so isolated. Take the Great Himalaya range coming up from Nepal. It runs along to Managa Parbat making a gigantic wall on the north and east, and gives off two big lofty branches—the Dhauladhar range, which runs north of the Kangra valley and south of Kashmir, and the Pir Panjal range, which is another gigantic wall about 30 miles wide, 15,000 feet high, and in parts always covered with snow, on the south and west of Kashmir.

The direct distance between the Punjab plains and the Kashmir valley is about 100 miles, and the climb up is from about 800 feet to 15,000 feet (see sections), while the direct distance from the plains to the Kangra and Kulu valleys is only about 28 miles. Thus, it would appear, a sufficient barrier keeps out the anopheline from Srinagar ; and if he got there, it is not likely he would thrive.

As to the two species found, Ne Willmorei has a very large distribution in the Punjab Hills and has been found to harbour malaria parasites in a state of nature. A barianensis is a very uncommon mosquito and was first found near Murree. Unlike most anophelines, its wings are not spotted.

To sum up in Srinagar and its neighbourhood, there is no endemic malaria ; there are practically no anophelines ; there is a certain amount of imported malaria with sexual parasites in the blood awaiting the visit of the anopheline ; but danger of thus spreading the disease must be extremely small, as local conditions are adverse to anophelines, and the possibility of an epidemic is ever so remote on account of the robust physique and the well-to-do-even luxurious condition of the inhabitants.

We are greatly indebted to and thank Lieutenant-Colonel Macnab, Dr. Mohan Lal and the Dr. Neve for much information and help.

A SHORT NOTE ON THE RELATION BETWEEN THE SEASONAL BIRTH AND DEATH RATE CURVES

By Major J. C. Robertson, I.M.S., Sanitary Commissioner with the Government of India.

In India the seasonal birth and death rate curves usually follow each other very closely, and this fact has generally been interpreted as indicating a direct correlation between the two, and the high mortality during the first year of life has frequently been put forward as the most obvious explanation. An examination of the accompanying chart however, which shows the births, by months, for the last 10 years in Bengal and also the deaths, for the same period, distinguishing between those of infants under 1 year of age and all others, clearly shows that this explanation is not the true one. From this chart it is apparent that, while at the periods of minimum total mortality the ratio of the infantile to total mortality (I use infantile mortality here in the sense of mortality amongst children under one year of age) is approximately 1 to 4, this ratio tends to fall, as the total mortality rises, till, when the latter is at the maximum, it is 1 to 5. The infantile mortality, instead of tending to force up the total mortality, in reality acts as a drag. Both have their maxima at the same time, but the total mortality rises relatively higher, than the infantile mortality and has really no direct connection with it.

It is not sufficient however, where curves correspond so closely, merely to deny their direct connection but it becomes necessary to give an explanation of the correspondence and of what is actually taking place. This, it appears to me, becomes quite clear so soon as we recognize that the similarity of contour of the curves of birth rates and total mortality is not due to any direct connection between the two, but to the action on both of the same outside cause malaria. The relation between the seasonal prevalence of this disease and the curve of total mortality requires no explanation but its connection with the curve of birth-rate is not quite so obvious though apparently, as seen in the chart, equally marked.

The effect of malaria on the birth rate curve appears to be due to its action, (*a*) in lowering the rate of conception, (*b*) in tending to cause abortion in early pregnancy and (*c*) in tending to cause premature delivery in late pregnancy.

Assuming now that, normally, the number of women liable to conceive, and the number of conceptions, would be approximately the same in each month of the year the tendency of malaria prevalent from August to October would be:—(1) to abort the conceptions of June and July, (2) to prevent conception from August to October, and (3) to cause premature delivery in the conceptions of the previous October, November and December.

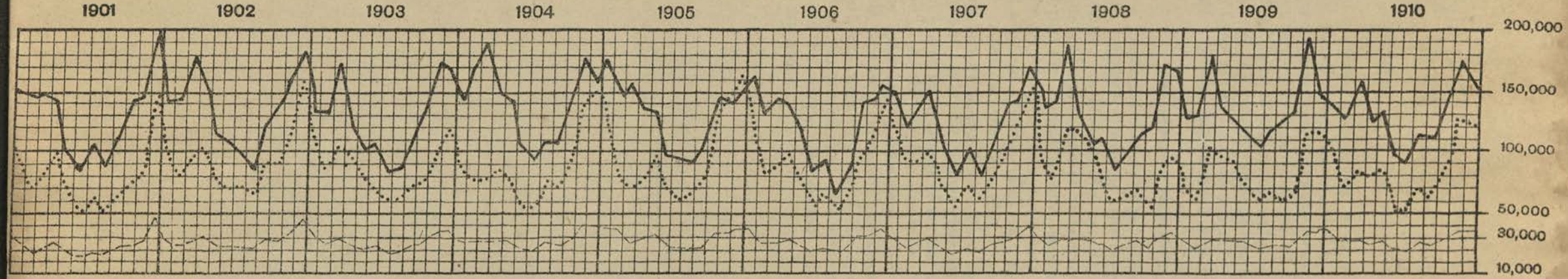
The cumulative effect would be to cause a preponderance of women liable to conception at the end of the malarial season and, allowing some time for recovery, a large number of pregnancies starting from January to March and a high birth rate from October to December (the exact months would of course vary according to the duration of malaria prevalence and its severity). As this sequence of events is repeated year after year the effect would become more marked. The birth rate and death rate curves are thus not directly connected, and while each is influenced by malaria, the latter is influenced by the malaria of the same year but the former chiefly by that of the year before. The maxima of the two curves fall close together but this is only a coincidence, due to pregnancy lasting nine months and malaria as a rule being prevalent for three months.

That the above explanation of the similarity of contour of birth rate and death rate curves is the true one is confirmed by the fact that, in places where there is a marked double malaria prevalence yearly, there is also, as we should expect, a corresponding double rise in the birth rate curves.

The explanation of the close connection between the infantile mortality curve and the birth rate curve is that from one half to one third of the deaths amongst infants occur during the first month of life and are due to non-seasonal causes. As births increase, therefore, deaths amongst infants increase also and in a fairly constant ratio. The chief exception to this is during the malarial season when the ratio of deaths amongst infants to births rises somewhat. This, in my opinion, is due more to the indirect, than to the direct, effects of malaria on the children. The former are premature birth, death of mothers and shortage of mothers' milk.

The effect on the annual death rate of an isolated or a continued high birth rate are quite separate questions and require separate consideration.

BIRTHS DEATHS AND INFANTILE MORTALITY IN BENGAL



REFERENCE

Births.....

Deaths above 1 Year.....

Deaths under 1 Year.....

S. D. O. No. 632 January 1913.

INTREVENOUS INJECTIONS AND SUBCUTANEOUS INFUSIONS OF QUININE SALT SOLUTIONS.

By Major A. C. MacGilchrist, I.M.S.

With reference to intravenous injections, I merely wish to correct a misapprehension regarding the dilution recommended by me in Scientific Memoir No. 41. In that memoir I gave 1 in 150 as the strongest solution which could safely be introduced intravenously without danger of *thrombosis*, but I did not recommend the use of solutions of this concentration. On page 38 it is stated that "preferably the quinine salt (*e.g.*, about 7 grains of quinine bi-hydrochloride) should be dissolved in *two or three pints* of normal saline". I recommend *great dilution* of the quinine salt. Quinine salt solutions 1 in 150 are very irritating.

Subcutaneous infusions.

Dr. W. M. James, Panama, has recently published a preliminary report on the use of subcutaneous infusions of quinine salts 1-150 in preventing the development of pernicious malaria. In Memoir No. 41 I made the observation that quinine salts in a dilution of 150 or weaker, if injected subcutaneously, were very rapidly absorbed, but that for clinical reasons subcutaneous injections of this dilution could not be employed for therapeutic purposes. Dr. James, however, has apparently found subcutaneous injections of this dilution quite practicable. My observation was based on the fact that in animals the injection of these solutions invariably led to very extensive ulceration and the ulcers took weeks and sometimes months to heal. Dr. James gave large doses subcutaneously in this dilution, (*e.g.*, 30 grains in 10 ounces of normal saline) and obtained excellent results. He states that the infusion was taken up in two hours and was not followed by any permanent induration. He used the bi-hydrochloride. There can be no doubt regarding the rapidity of absorption, but I feel sure that there must be extensive local disintegration of the tissues at the seat of infusion. There will, however, be no precipitation of quinine or coagulum-formation and possibly on this account the danger of tetanus will be much less than after ordinary hypodermic injections.

QUININE PROPAGANDA

By Dr. Chas. A. Bentley, M.B., D.P.H., D.T.M. & H., Special Deputy Sanitary Commissioner, Bengal.

Attention has already been drawn in another paper to the fact that the failure on the part of medical men to clearly distinguish between the disease which may result from the presence of the malaria parasite, and the condition of mere parasitic infestation, has led to much confusion in the past.

And in no case has this confusion been more apparent than in discussions regarding the prevention of malarial disease, and the relative merits of different measures of sanitation directed against it. These discussions have usually taken the form of comparisons of antimosquito measures with those directed to popularising quinine. But it is generally admitted that antimosquito sanitation properly carried out will prevent the occurrence of infection, and is equally well recognized that, when infections have once occurred, the use of quinine administration will check or control the manifestation of disease which may result, so that the discussion of the relative importance of the two measures is as futile as comparing the means to be adopted for preventing fires with those that must be used to control an existing conflagration.

And just as the discovery of cinchona first placed in the hands of civilized man a weapon whereby he could preserve his life when attacked by the malaria parasite, so the discovery of the mosquito cycle of the malaria parasite placed within his reach the power of avoiding all danger of attack. And it is certain that so long as the malaria parasites continue to disturb man's comfort and endanger his life, in proportion as nations advance in civilization they will continue to make use both of quinine and antimosquito measures to an increasing extent.

For many years to come therefore the increasing consumption of quinine by the population of a malarious country will afford an index of advancing civilization; and until malarial infection has been brought under complete control the diffusion of knowledge regarding the remedy and the provision of facilities for its distribution will continue to remain a responsibility of the State.

At the present time the world's supply of quinine is about 17,000,000 ounces annually, sufficient according to the latest views to afford really efficient treatment to about 18,000,000 cases of malaria. India consumes each year about one-sixth of the total quinine produced, sufficient to treat efficiently about 3,000,000 cases of malaria *per annum*, or to afford temporary relief to about 12,000,000 sufferers. But even if India were to absorb the whole available supply of quinine, many cases of malarial disease would still remain untreated. And at present, in spite of the fact that quinine is known by name in probably every village in India, only a fractional proportion of those who annually suffer from malarial disease use it at all, and still fewer take it in a manner likely to produce any appreciable effect.

Although Government quinine is in sale in every post office in Bengal and by a certain number of other vendors, the total amount of the drug disposed of through these agencies represents a consumption of less than a grain per head of the population; and owing to the intense ignorance of the general public regarding its proper use, it is probable that a considerable proportion of this is absolutely wasted.

A recent investigation into the amount of quinine consumed in a number of dispensaries in charge of trained medical men (sub-assistant surgeons and assistant surgeons) showed that 100,000 cases of malarial fever admitted for treatment received a total of 197¼ lb. of quinine or 1,380,750 grains of the drug, an average of 13·8 grains per case. This is about a seventh of the amount required to afford them even temporary relief, and about a thirtieth of that required to effect a cure, and it is typical of the methods employed by the majority of Indian practitioners in the treatment of cases of malarial disease. And if trained medical men waste quinine in this way, what can be expected of the masses of the population? But the mere waste of quinine is but a small evil compared to the bad effect produced upon both patients and medical men by the inefficient use of the drug for the treatment of

malarial disease. Unfortunately the patients who attend dispensaries are all aware that they are given quinine for malarial fever. Thus all over the country month by month medical men are busy convincing both themselves and many thousands of unfortunate sufferers from malaria by the process of practical demonstration that quinine is a more or less useless remedy for the condition.

A consideration of these facts prompts the query—How does the general public in India obtain the knowledge of quinine?

The vast masses of the people are still illiterate and can only learn of quinine by word of mouth, either from those who have made use of the drug, have heard or have read of it. But as we have already seen the vast majority of those who receive quinine treatment must get in in such a manner as to obtain no obvious benefit from it. Therefore the testimony of the vast majority of those who can speak from experience must be against rather than in favour of its use. Unfortunately also the literate population who may be able to gain some knowledge of quinine in other ways than by experience or by word of mouth, although apparently in a position to obtain better information than the illiterates, are really worse off under present conditions. For although there are any amount of anti-quinine advertisements, handbills, pamphlets, and almanacs circulated broadcast all over the country, pro-quinine advertisements are only occasionally met with. In Bengal, as was mentioned at last year's malaria conference, the campaign conducted by quack medicine vendors against quinine has been so successful that the terms "Quinine Atkan jor" and "Quinine Abund jor" are recognized all over the country as referring to a condition of "fever suppressed and rendered liable to recur through the use of quinine" or more literally "a fever bound or fixed in the body by quinine."

But in addition to the advertisements of quack medicine vendors there are other agencies constantly at work prejudicing the population against quinine. Nearly every village in Bengal possesses at least one kabiraj, to whom a very large proportion of the people go when suffering from sickness. The majority of these men make a point of warning their patients against the use of quinine. In recent years also a number of other irregular practitioners have appeared who profess homœopathy; and as is well known homœopaths invariably decry the use of quinine and attempt to influence people against it.

Thus numberless agencies are at work among the population misdirecting them in regard to the only potent remedy we possess against malarial disease, whereas the measures adopted to educate the people in regard to its value are almost non-existent. Here and there a few handbills or pamphlets are distributed by enthusiastic civil surgeons and district officials; and no doubt the example of the small number of people who really know the value of quinine and use it acts as some slightly educative influence; but on the whole the population is left pretty much to its own resources for information regarding the value and use of quinine.

In the past it was assumed that the use of quinine among the general population could best be extended by arranging that supplies of the remedy should be obtainable either at cost price or below it; and Provincial Governments have from time to time earmarked special budget grants for the purpose of meeting the loss occasioned by the sale of quinine on these terms. The reason usually put forward in support of this policy has been that quinine is thus brought within the reach of the poorest classes of the community.

But when we come to enquire into the class of persons who avail themselves of cheap Government quinine it soon becomes apparent that the vast majority of those who purchase it are not the people who can barely afford to spend a pice on medicine. People in this position do not usually buy medicine at all. The bulk of those who purchase cheap quinine from Government vendors are either those who can well afford to pay full price for the remedy, or those who buy it in order to retail it again at a profit. This has been more apparent in Eastern Bengal since the introduction of the "treatment system." In one district the agent who disposes of the largest amount of quinine "treatments" supplies the bulk of them to shopkeepers in a neighbouring bazaar, who again retail it. The usual price at which it is retailed is one pice per tabloid. Careful enquiry has also brought to light the fact that even in mufassal areas, purchasers of quinine are usually either subordinate Government

officials, or educated people in a good position. And where a poorer class of Indian is concerned he is usually the man who does not hesitate to spend Re. 1 on a bottle of Edwards Tonic, Rs. 1–4–0 to Rs. 1–12–0 on D. Gupta's specific or from 8 annas to 12 annas on a less well-known quack medicine.

In some cases it has been found also that even highly-paid Government officials not content with purchasing treatments in the ordinary way through a post office, have applied for and sometimes obtained a single box of ten tubes direct from the Civil Surgeon's office, presumably in order to save the 7 annas commission allowed to retailers. They have obtained in this way 200 *tabloids* at a price of Rs. 1–7–0 and at a loss to Government of about Re. 1. Had they purchased a similar quantity of tabloids in the ordinary course of business from a druggist they would have to pay about Rs. 4 for it.

It may be pointed out that such abuses as those mentioned above would not have arisen except for the adoption of the pernicious policy of supplying quinine below cost price. This policy was adopted mainly on sentimental grounds; and is not only economically unsound, but cannot possibly achieve the object intended, the popularization of quinine among the poor.

The original idea was that a single dose of quinine should be obtainable for a pice; and the amount of quinine at first supplied for this price was 5 grains. But in Bengal this has been increased first to 7 and then to 10 grains. And at the present time in the portions of the province not yet supplied with "treatments" a 10-grain powder or a packet containing 3, 3½ grain tablets of quinine is obtainable at a cost of one pice.

But the pice packet system is open to grave criticism on several grounds. In the first place a single dose of quinine, however large, cannot give even temporary relief from an attack of malaria, and the man who purchases one or even two or three pice packets is virtually throwing his money away. The administration to an adult of anything less than a 100 grains of quinine sulphate (or its equivalent) is not likely to afford even temporary benefit in a case of acute malarial disease. This amount of quinine if purchased in pice packets (10 packets) would cost 2½ annas. Thus unless a man can afford at least 2½ annas his purchase of quinine under the pice packet system is largely wasted. The pice packet system therefore actually tempts the poor to waste their money fruitlessly.

In those provinces in which the sale of quinine by post offices and other vendors has been put in an organized basis it is often assumed that other measures are not required. And even when it has been urged that efforts should be made to popularize the drug and extend its sale, the proposals usually take the form of a suggested increase in the number of vendors.

But the mere increase in the agencies for the sale of an article for which there is little or no demand is not likely to do much to popularize it and increase its use among the people. Moreover an examination of the figures regarding the sales of quinine in Bengal reveals the fact that at the present time the vast majority of existing vendors of Government quinine dispose of an exceedingly small amount of the drug in the course of the year. As has been previously mentioned, the majority of vendors of Government quinine are postmasters. Probably on the average each post office in Bengal serves at least 10,000 people, and in many districts from 6,000 to 10,000 people are to be found residing within a two-mile radius of every post office. In malarious areas nearly every one suffers one or more attacks of malarial fever during the course of the year and yet in spite of the fact that the vast majority of them know both that quinine is used for malaria and that it is obtainable close at hand, only a fractional proportion of them avail themselves of it. In 1911, 4,114 vendors of quinine in the districts of Western Bengal, Orissa, Chota Nagpur and Behar disposed of a total of 23,194,000 grains of quinine sulphate or an average of nearly 13 ounces per vendor. Taking 100 grains as the minimum amount likely to afford temporary relief in a case of malarial fever on the average each vendor sold sufficient of the drug to really benefit 57 people. So that on the assumption that quinine was purchased in this manner only 231,940 people or less than 1 per cent. of the population can have received benefit from it.

During the same period 197,180 tubes of treatments each containing 20·4 grain tabloids of quinine hydrochloride (a total of 80 grains) were sold by post offices and other agencies in the Eastern Bengal districts which possess a population of over 28,000,000 persons. These figures show how small the demand for quinine among the population really is.

In 1911 in the Faridpur district 169 vendors of Government quinine disposed of 19,450 tubes of treatments or an average of 115 tubes each, but 104 of them sold amounts far below the average and little more than a dozen of them sold more than 250 tubes each. In the Dacca district about 250 vendors disposed of just over 12,000 tubes in the same period, an average of 40 tubes per vendor. In the Jalpaiguri district and Coochbehar, which is one of the most malarious areas in Bengal, 141 vendors sold only 4,680 tubes of quinine, an average of just over 33 tubes per vendor. In the Dinajpur which is also extremely malarious 84 vendors sold 7,510 tubes of treatments or an average of 89 per vendor. From these figures it is evident that it is not the lack of facilities for obtaining quinine that prevents the rapid expansion in its use. If each of the vendors mentioned above were to sell on an average only one tube of quinine per day, the total sales in the four districts would increase five-fold; and as a matter of fact they could easily supply 50 times the amount without inconvenience, if there were a demand for it.

It has sometimes been suggested that the popularization of quinine would be furthered by increasing the profits allowed to the vendor. But although the commission allowed to agents in Eastern Bengal and Assam has been increased to 30 per cent. it has not apparently affected this purpose. And on theoretical grounds it might hardly be expected to do so to any great extent. For if there is no demand for an article it makes little difference to the agents who stock it, whether their legitimate profit is 10 per cent. or 100 per cent. on the cost. The present demand for quinine in Bengal is so small that the existing vendors get a very small return for their trouble. The profits received by the 4,114 vendors of quinine in West Bengal in 1911 only averaged Rs. 1–4–0 per vendor per annum. In the Faridpur district the average legitimate profit on the year's sales, in spite of the 30 per cent. allowance, only amounted to Rs. 5 or about $6\frac{1}{2}$ annas per month; and of the 169 agents only 13 earned an average of as much or more than Re. 1 per month. The earnings of vendors in the Dinajpur, Jalpaiguri and Dacca districts were still more meagre, averaging for the year less than Rs. 4, Rs. 2 and Rs. 1–8–0 respectively.

In the foregoing pages it has been shown that in spite of the fact that India consumes a very large amount of quinine, a very small proportion of sufferers from malaria make use of the remedy; and a still smaller number derive benefit from it owing to the ignorant manner in which it is often employed. This general ignorance regarding the value and the proper way of using quinine is due to the almost complete absence of educational measures in regard to it. The means that have been adopted in the past with a view to popularize quinine have failed to achieve that object. The pice packet system instead of benefiting poverty-stricken sufferers from malaria has frequently caused them to waste money fruitlessly. And the selling of quinine at or below cost instead of benefiting the poor has saved mainly the pockets either of those who could afford to pay a full price, or those who wanted to resell the drug at a profit. The attempt to stimulate the sale of the remedy by merely increasing the profit allowed to vendors has not produced any great expansion of consumption; possibly owing to the fact that demand is so small that even were 100 per cent. profit allowed, the actual net returns obtained by many vendors on the sale of quinine would still be so small as to offer no inducement to push it. The mere increase of agents under these conditions is not likely to do much towards causing the masses of the public to appreciate quinine.

A consideration of these facts points to the conclusion that the existing quinine policy in India is a failure. And the cause of this failure is the lack of a business-like organization for enlightening the general public in regard to quinine, creating a demand for the remedy, and supplying the demand thus created.

In Italy a special department which controls the manufacture and distribution of quinine and arranges for the education of the public in regard to it has been in

existence since ten years and the results are shown in the quotation from a report given below :—

" The issue of quinine has increased from 2,242 kilogrammes in the financial " year 1902–03 " to 23,635 kilogrammes in the financial year 1908–09 " and the net " profits of the administration of State quinine have in consequence increased from " 34,220 Lire (about Rs. 20,317) to 769,809 Lire (about Rs. 4,57,073). These profits " are not dealt with as ordinary State revenue, but are applied to combating malaria."

Some such policy as that indicated in the above paragraph is urgently required in India.

Europeans and anglicized Indians, troops both British and Indian, the jail population, sufferers admitted to the large hospitals and mission dispensaries, and tea garden coolies, are probably the only persons really receiving adequate quinine treatment. Other sufferers from malaria either get no quinine at all or receive it in such inadequate doses or for so short a time that it does them little or no good.

Broadly speaking we may divide sufferers from malaria into two classes : those who can afford to pay for treatment and those who cannot. Under the existing system the vast majority of those who can afford to buy quinine do not do so and of the few that do, some obtain Government quinine at below cost and the others obtain it from dealers often at an extravagant price. The class who cannot afford to buy quinine are not benefited in the least by the cheap rate at which it is sold by Government, and as we have seen, the gratuitous treatment they get at rural dispensaries is often hopelessly inadequate.

The remedy for this condition of things is to be sought in the complete reorganization of the system under which Government quinine is at present supplied to the people. More quinine must be sold and far more quinine must be given away. The only rational way to sell an increased amount of quinine is to set about creating a demand for it. To this end therefore arrangements should be made for selling quinine to the general public in a businesslike manner.

It is now generally recognized that the minimum amount of quinine required to eradicate a malarial infection is about one ounce. To effect a cure a simple method is to administer about 20 grains a day for three weeks. The simplest way of administering quinine is in readily friable tablet form ; and $3\frac{1}{3}$ grains is a suitable size for nearly all purposes. To afford even temporary relief from an attack of acute malaria a minimum of about 100 grains of the quinine sulphate or its equivalent is required. Two sizes of bottles of quinine tablets should therefore be put up for sale to the general public, one containing 126 $3\frac{1}{3}$–grain tablets and the other about 30. The former should be labelled as a " complete treatment " for malaria, the latter as a " relief treatment " and this latter point must be emphasized. Full directions should be given as to dosage, and the wrapper should contain a short history of quinine and an account of malaria. Instead of being sold at a loss or at cost price, these bottles should be priced so as to allow a small profit after meeting all commissions and discounts.

Having arranged for the supply of bottles of tablets put up in this way, they should be extensively advertized. Every newspaper in the country should contain an advertisement, unless its circulation was hopelessly small. And as the quinine should be intended for sale to the general public, the newspapers circulating among the European population should not be omitted in the scheme. The aim should be to sell a sufficient amount of quinine on terms that would be advantageous to the ordinary purchaser and yet allow a sufficient profit to produce revenue which might be expended in special grants of quinine for free distribution to the poor through existing dispensaries and hospitals and other trustworthy agencies.

There is no reason why 50,000 pounds weight of quinine should not be sold in this way every year. This amount would represent about 800,000 larger size bottles of tablets. And at a profit of only 1 anna a bottle the net revenue of Rs. 50,000 would be obtained. A more suitable profit would be 4 annas on a larger bottle and 1 anna on a small bottle. And this profit would give Rs. 2,00,000 revenue on 50,000 lb. of quinine. With this amount of money it would be possible to supply something like 25,000 lb. of quinine in the form of free grants to supplement that already distributed to the poor by dispensaries and other institutions.

The existing organization for the distribution of quinine to vendors in rural districts is badly in need of reform. At present in Bengal the civil surgeon's office in each district is the distributing depot, and the civil surgeon's clerk is the man who sees to the distribution of quinine to postmasters and other vendors. But this system is most unsatisfactory for it often happens that postmasters have to apply again and again before they can get their orders filled. This is because the whole system is a makeshift. It was originally introduced as an experiment and because it was thought to be a cheap way of getting the work done; and though a very inefficient system it has been allowed to become permanent.

In rural districts it will be necessary to rely upon existing retail vendors for a time; but experiment should be made at first in one district in regard to distribution methods. In the chosen district one agent should be appointed to look after the supply of quinine to retail vendors; and the depots for quinine should be the treasuries and sub-treasuries of the district. The officer appointed to look after the quinine should be required to deposit security equal in value to the largest amount of quinine which would at any time be in his control. He should receive a salary and a small commission on the sales. His duties should be to travel round the district supplying retail agents with quinine and pushing the sale of the remedy by every possible means. He should be allowed to supply selected persons with a limited number of bottles of quinine tablets in advance of payment, collecting the price of any bottle sold at his next visit. As he would only receive commission on cash actually paid into the treasury there should be no great danger of loss or fraud, so long as adequate security was originally insisted on.

In the district or districts selected for this experimental organization, every available method of interesting and educating the general public should be adopted in addition to the newspaper advertisements. Lessons and lantern lectures should be given in every school, and other suitable places; placards and posters should be used freely; and almanacs, handbills and pamphlets should be distributed after each lecture.

It should be easily possible by these means to increase the sale of quinine in a district from 5 to 10 times, within a very short space of time. In the rural districts probably more "relief treatments" would be sold than "complete" ones. If 80,000 of the former were sold in the experimental district at a profit of 1 anna a tube, a total amount of Rs. 5,000 would be available for expenditure on grants of gratuitous quinine to dispensaries, etc., there.

In conclusion attention must be called to another matter. If the consumption of quinine expands to any great extent in India, which already takes one-sixth of the world's supply, the price of the alkaloid will speedily rise. The bulk of the world's supply now comes from Java. But at one time Ceylon produced a considerable amount of cinchona bark. In 1886 15,000,000 lb. of bark was exported from the island; but in 1910 the exports had fallen to 80,000 lb. For a number of years past quinine has stood at such a low price that the bark producers have had but a small margin of profit. Under these circumstances it is hardly likely that they have continued to plant largely in the face of stagnant markets; and there is a great risk therefore that a rapid advance in price of the drug may take place at any time.

At the present time there are some thousands of acres in India planted with cinchona trees; but in order to minimise the risk of a great enhancement in the price of quinine in the early future it would be well if the acreage under cinchona was largely extended. Once in the past the policy of the Indian Government led to the whole world benefiting by a supply of cheap quinine; and it is quite possible that if India takes steps to extend the culture of cinchona at the present time she may not only protect her own interest, but once again benefit every malarious country in the world by ensuring a continuance of the inestimable benefits of cheap quinine.

SCHOOL QUININISATION EXPERIMENTS IN THE UNITED PROVINCES

By Major J. D. Graham, M. B., D.T.M., I.M.S., Special Malaria Officer, United Provinces.

The various methods of quinine prophylaxis employed throughout the malarial world have one feature in common—their dependence for success upon some degree of discipline or control in the community being quininised. Organized communities such as jails and asylums labour under such a considerable advantage in this respect that they are looked on as eminently suitable for the adoption of such measures, with a reasonable assurance of their being carried out in their entirety. When, however, we come to deal with the civil community at large, the adoption of any scheme of prophylaxis on a large scale becomes difficult, if not impossible, both from the point of view of organization and from that of expense, while the results accruing are likely to be uncertain. In the civil community, however, the school organization comes perhaps nearest in point of discipline to that of such examples as we have above cited, and the scholars while they are in actual attendance, can be controlled just as effectually. The experiment of prophylaxing the scholars in a selected number of schools in any district has then as desiderata in its favour the facts that the community concerned consists of children or young adults well organized and disciplined during seven hours of each school day, who are highly susceptible to malaria, and who are, moreover, in process of mental moulding, keenly observant, fairly unbiassed and in a position to remember any object lessons and perhaps retail them at home—in short a community whose powers of disseminating information are considerable. If we add to this the enormous force of example, we are, I think, at liberty to assume that such an experiment, even in an ordinarily mild fever year, has a very definite educative value for the general community which no crusade of oratory or pamphlets can either approach or supplant.

The first attempt at school quininisation experimentation on systematic lines in the United Provinces was made in the district of Muttra by Major Robertson, I.M.S., in the rains of 1909, when the country was beginning to recover from the heavy toll that had been exacted by the epidemic of 1908. Muttra had been the worst affected of all the districts in the provinces and the passing of the epidemic had left its mark on the bulk of the population under ten years, so that huge spleen indices, very large spleens, mixed infections and relapses, were the features of the school examinations then undertaken. Though Major Robertson did not write a report on the experiment, the writer understands that he systematically quininised a large number of the worst schools during three months, and that, at the end of the period, the results were regarded as eminently satisfactory, and of sufficient value to suggest more detailed experiments on similar lines in the future. Such an experiment was undertaken by the writer in the rains of 1910, in the district of Budaun, a district which had suffered severely during the epidemic of 1908, and where the district authorities seemed specially keen on working at the problem and on giving every assistance. The results of this experiment have been recorded by the writer in a "Report" addressed to Government in February 1911 and since published.

In this report is recorded a full and detailed outline of the whole experiment with the conclusions arrived at, and, as the report was circulated throughout the province, every opportunity was given to the different district authorities to digest the details, and modify them to suit local requirements if they felt inclined. The results recorded were distinctly satisfactory; but, as the autumn of 1910 had not a severe malarial incidence, it was thought desirable to attempt on similar lines, in the autumn of 1911, the quininisation of a series of schools in two badly affected districts, and the districts of Meerut and Aligarh were chosen. These districts, which are situated in the Jumna-Ganges Doab, are highly canalised areas, well supplied with schools, and very accessible, and have shown over a long period of years continued heavy mortality from endemic malaria, as well as

very heavy mortality on occasions from epidemic malaria, so that they were considered eminently suitable. It is with this later experiment, then, that the present paper will chiefly deal.

General Arrangements.—In consultation with the district officers, a typical series of school was selected, embracing practically all the district climatic peculiarities. Sample head lines of a quinine attendance register had been previously distributed throughout the schools to be visited, and by the time of my arrival, all schools had been provided with identical registers in which the scholars' names had been entered class by class. These registers showed columns for class number, name, sex, age, spleen, general health, dose, dates of dosage and remarks. Personal examination of every child in every school at the inception of the experiment, to note the size of spleen, general health, and age, and to fix a prophylactic dose calculated on age and physical development, though tedious spade work, can rapidly be overtaken in these days of motor transit, whilst a similar personal examination at the termination of the experiment made the data complete and comparatively free from error, which they would not have been, had this been delegated to subordinates.

Distribution.—To eliminate as far as possible any local bias against the drug, its distribution was entrusted to two sub-assistant surgeons, for whom a weekly cyclical programme was drawn up, embracing the majority of the schools in each district, though a few schools because of their inaccessibility had to be entrusted to the sub-assistant surgeons at district dispensaries, whilst in several instances district sanitary officers assisted. In this way the general accuracy of the tabulated results was ensured, whilst each school was able to be seen twice weekly in 1911, a factor of some importance.

Quinine.—Quinine in the form of the sulphate in 1910, and of the bisulphate in 1911, was issued throughout all the experiments in uncoated tabloids of $\frac{1}{2}$, 2, 3 and 5 grains, given dry, and washed down with water, and was swallowed without difficulty. The stock was kept in the 1910 experiment with the Civil Surgeon of Budaun, but in 1911, with the respective District Board Secretaries of Meerut and Aligarh, and was issued as required (usually weekly) to the distributors. Throughout the whole period very few cases of intolerance were reported, and conscientious objectors, though they existed and were respected, never established cases really worthy of consideration.

Dosage.—The question of dosage the crux of any prophylactic experiment was necessarily experimental, and was fixed as low as possible and in many cases too close to the border land of inefficiency. The adult dose was fixed at grains 18. A useful method was evolved of adding 4 to the age and making this the denominator of a fraction the numerator of which was the age. Thus for a boy aged six, the fraction of the adult dose was $6/6+4=6/10$ or $3/5$ or about 10 grains weekly. This was given irrespectively of evidences of malarial infection such as enlarged spleen, general appearance or history. In the 1910 experiment single weekly doses, and bi-weekly doses on successive days and on intervening days, with grains 8, 9, 10, 12, 15, 16, and 20 weekly were tried, giving in all eleven bases of dosage; but in practice this was found by its multiplicity to confuse the issue. Accordingly, in the 1911 experiments, the weekly scale was limited to grains 12, 18 and 20, and was given twice weekly either on successive days or with intervening days, giving in all 5 bases of dosage.

Girls' schools, which had been included in 1910, were excluded in 1911 because of the unreliability of the registers and the irregular attendence. The test extended over the three fever months, August, September, and October, and into November in one case, the final examination being concluded when the distribution had ceased.

Throughout the 1910 experiment, continuous weekly blood examination of proved gamete carriers was attempted and gave some interesting information; but, owing to paucity of gamete infections in 1911, it was abandoned. Local conditions were, however, considered much more in the 1911 experiment than previously in arranging the programme of schools, and also influenced to some extent the basis of dosage. This we shall see was attended with benefit.

In trying to deduce from tables of results the respective values of different bases of dosage, as one is very tempted to do when looking for practical conclusions, the reader is warned of the numerous pitfalls which beset him, owing to many other factors than the mere quininisation coming in to influence these results, so that too much importance should not be placed on them.

The choice of schools in both Aligarh and Meerut was influenced to some extent by a perusal of the malaria intensity figures for thirty-two years of the rural circles of the districts, and the schools in both districts assort themselves into four groups.

(*a*) A Khadir group.

(*b*) A canal or riverain group.

(*c*) A road group (2 miles at least from canals).

(*d*) A town or city group.

It is obvious that dosages only just sufficient to influence a group such as the city group, would be hopelessly insufficient to prophylax effectively a group like the Khadir group, when it is remembered that the spleen indices of the two areas might vary between 5 per cent and 60 per cent. An attempt to cope with this was made by putting all such highly endemic areas on the high scale of 18 or 20 grains, while the town group were kept on the lowest, 12 grains. In this way results were found to work out very uniformly.

Let us now consider the results obtained in each of the three districts.

Dosage in relation to spleen.—Observation of alterations in the existing splenic enlargements, if made by the same individual at both examinations, is of considerable value.

In Budaun in 1910, 54 schools with 2,881 scholars showed a decrease of spleens due to complete disappearance as measured by palpation of 58·4 per cent; a control of 247 non-quininised boys enrolled after the experiment had begun showing 30 per cent of spleens in November at a time when the quininised showed 7·6 per cent.

In Meerut in 1911, 45 schools with 2,648 scholars showed a decrease of spleens due to complete disappearance of 48·3 per cent; a control of 702 non-quininised scholars enrolled after the experiment had begun, showing 15 per cent of spleens in November at a time when the quininised showed 7·6 per cent.

In Aligarh in 1911, 48 schools with 3,254 scholars showed a decrease of spleens due to complete disappearance of 56·8 per cent; a control of 1,029 non-quininised boys enrolled after the experiment had begun, showing 16·8 per cent of spleens in November at a time when the quininised showed 7·8 per cent.

Briefly the spleen rate of the non-prophylaxed boys in November was practically the same as was that of the scholars in July, while the prophylaxed boys showed a reduction by complete disappearance of about 50 per cent. This happened with every basis of dosage even though only a per centage varying from 79·7 to 88·3 of the available quinine was consumed.

Twelve grains in the city was found to produce much the same percentage of reduction as did 18 and 20 grains in the canal and Khadir schools, *i.e.*, the proportionate reduction was much the same in all. By grouping the schools according to proximity of spleen indices in periods of ten units each, *i.e*, schools with spleen index from 0 to 10, 10 to 20 and so on, we can contrast the dosage effects in comparable schools and this shows that 18 grains bi-weekly "intervening", and 20 grains bi-weekly "intervening", are the most successful; but, as already pointed out, too much reliance should not be placed on any deductions one is tempted to make regarding efficiency of individual dosages, though the figures indicate that such doses as grains 18 and 20, when employed under moderately severe endemic conditions, are of unquestionable utility in the reduction of individual enlarged spleens, when gauged by numbers sufficiently large to exclude numerical fallacies.

Dosage in relation to fever incidence.—The influence of different dosages on fever incidence is another of the primary tests which enables us to estimate the success of the prophylaxis. The percentage number of cases in which fever occurred during the exhibition of the drug will more than represent the measurement of failure to prophylax.

In Budaun in 1910 we failed to prophylax in 10·6 per cent of the pupils when 80·1 per cent of the doses were consumed.

In Meerut in 1911, we failed to prophylax 8 per cent of the pupils with 81·3 per cent of doses consumed.

In Aligarh in 1911, we failed to prophylax 9·4 per cent of the pupils when 76·5 per cent of doses were consumed.

In this connection we must allow for—

(*a*) previous latent infection,

(*b*) irregular consumption of dosage,

(*c*) defective diagnosis. As pointed out recently by Ross and Thomson in connection with their enumeration experiments, it can hardly be accepted, in the absence of accurate enumeration observations, that apparent rises of temperature during a period of quininisation are necessarily relapses or even malaria, and this factor alone would go towards diminishing the apparent failure.

The point elicited however by the figures is that we were sailing close to the border line of inefficient prophylaxis, and further, that the more thorough the administration, the less was the fever incidence and spleen development. In estimating the relative values of individual dosages, grains 18 and 20 bi-weekly "intervening", would appear to give the best results and this too when applied to the severely affected riverain, canal and Khadir areas. As has been repeatedly pointed out, it is premature to argue efficacy of a particular dosage over others, when local conditions vary so greatly. A careful study of the available figures brings out clearly the necessity for graduating doses according to locality, and so making the prophylaxis less empirical. In the Meerut district a grain 12 dosage in the towns does apparently what a grain 18 dosage does in the Khadir and riverain tracts. It would naturally be expected that a grains 18 dosage would do more in the towns than a grains 12 dosage. The present tests do not touch this, however, but the figures prove that all dosages are efficacious when exhibited intelligently.

Various estimation methods which were studied have been omitted in this general sketch, but appear in full in the original papers, together with a large quantity of statistical proof necessarily omitted, and to these the reader is referred for details.

Bloods.—In Budaun in 1910 the careful weekly examination of gamete carriers during the exhibition of the drug disclosed three conditions:—

(1) Gametes or other forms are found right through the fever season, even in cases where no absences are recorded, *i.e.*, where all the quinine available has been consumed. This is especially marked in malignant infections.

(2) Several infections, mostly benign tertian, seem to be controlled from the commencement, and to remain so till the end, even in spite of absences, and therefore diminished quinine consumption.

(3) Original infection is more or less controlled, but has a second infection, probably a reinfection, grafted on to it during the fever season.

Curiously, recurrence of old infection does not always seem to vary inversely as the number of doses, as one would expect, but other factors such as the general health, degree of infection, and amount of the dose, all enter in to complicate the issue.

In Meerut and Aligarh in 1911, regular observation of the blood of gamete carriers on the above lines was found impracticable. Though these schools showed spleen rates varying between 3·6 and 69·2 per cent, and 8·1 and 56·7 per cent, respectively, the blood infections discovered were few. Meerut showed 13·4 per cent in July and 1·9 per cent in October; Aligarh 3·4 per cent in August and 1 per cent in November-December. The malignant parasite predominated. There is every sign that, despite the rainy season, not only did recrudescence not take place in the majority of latent carriers, but that actual infections also decreased, and it is more than likely that the quinine exhibited helped towards this result.

Evidence of temporary immunity.—Reference to school registers shows that the percentage absence due to fever, after quinine distribution ceased, was much greater than it was during the test; indicating that a degree of temporary immunity existed during the test.

Size of spleen.—In the non-quininised scholars seen in November, the fresh spleens noted were proportionately larger than were those in the quininised scholars (*i.e.*, the increase in the non-quininised was greater than that in the quininised).

Teachers and staff.—As the teachers form an adult community comparable in regard to age in all three experiments, they have been considered together.

Five hundred and ten teachers in the three experiments consumed 92·6 per cent of the available quinine, and showed only sixteen cases of fever, four of whom developed slight spleens. The average dose received was 14·1 grains in Budaun, 18·2 grains in Meerut and 16·7 grains in Aligarh. The figures show a high degree of prophylaxis.

Cost.—The expenditure involved in such experiments is a practical point which very often must decide for or against its adoption. The working expenses of Budaun in 1910, inclusive of the pay and travelling allowances of the special distributors, were approximately Rs. 1,163, or 6·5 annas per head; Meerut cost Rs. 1,360, or 6·2 annas per pupil; Aligarh Rs. 1,725, or 7 annas per pupil. In all these instances the expenditure could be reduced to about one half by depending on local distributors entirely; but in the tests the employment of special men for the purpose was valuable as ensuring increased accuracy of work. In the three experiments the District Boards supplied funds up to a certain amount, beyond which Government made a grant; but the fact that several District Boards have since and are at present financing their own programmes, bears out the writer's contention, that, practically, the cost can be reduced to one half that given, or roughly, to about 3·5 annas per pupil for the fever season.

Other points.—It would be helpful in new districts first to ascertain the malarial conditions, both from malaria intensity figures, if available, and by a perusal of local statistics, and in this way variation of dosage to suit locality could be made possible. As a rule grains 18 should be the minimum weekly dosage for the adult male community, and, given bi-weekly with intervening days, it seems to afford the best results with the least disturbance; but, as a working rule, smaller doses could be given in large towns and dry areas away from canal irrigation. Registers should always be kept, as the mere fact of having a register makes the distribution appear part of the school curriculum, and ensures more care being taken over it.

Wherever it is attempted, a carefully thought out programme should be worked out in advance before the onset of the rains.

Once the potentialities of a civil district as regards locality, spleen incidence, and effects of dosage over one or two years are known, it should be possible to frame a rational plan of campaign in regard to dosages, which could be followed out from year to year, and modified to suit increasing or decreasing fever incidence.

Objects.—It may be asked what are the objects of such a crusade when fever is mild. These may be classed under several heads.

(a) *Educative value.*—To an active boy nothing can well be more impressive than an untreated attack of fever which lays him low for several days, weakens him and keeps him from his games and from school.

What must be the effect on a group of boys, all of whom are being quininised with success, when they see one of the class who has consistently refused the weekly dose, or who has been absent so often as to have received little or no prophylaxis, suddenly struck down or suffering severely from fever while they escape; yet this object lesson time and again was demonstrated in class after class of the various schools. So marked was it that the masters very often came to associate frequent absence with indifferent prophylaxis and regular attendance with systematic dosage. Moreover, the illness of such boys must have formed a subject for common gossip both at home and in the play ground, thus impressing the family circle with the value of the drug. The testimony to the increasing regularity of the attendances of the children in the rains since the tests were inaugurated, was almost unanimous on the part of both teachers and parents whom the writer saw, and quinine and this regularity were placed in the relation of cause and effect, with some justification, by most of them.

(b) *Prophylactic and destructive aspects.*—Fresh infection or reinfection is thus prevented and the risks from latent carriers of infection are diminished.

(c) *Dosage and therapeutic aspect.*—Information regarding the variations of dosage which appear most efficacious and the local conditions requiring that these doses should be modified, is thus accumulated for future guidance, while the direct effect on actual infection by diminution of splenic enlargement and increased standard of general health is as important a consideration for children as it is for adults.

Applicability.— Any scheme on lines similar to those described, can be initiated locally without such detailed examination as was made in these tests, and, with the help of the district authorities, can be run by an intelligent assistant surgeon or district sanitary officer, while the transition from a free issue of quinine in the 1st year, to, in the 2nd year, a quinine register, for enrollment on which a small inclusive charge for the season could be exacted, is comparatively easy. This is all in progress at the present moment. Thus in 1911, Budaun on its own initiative, after the success of 1910, carried through a similar experiment, when a proportion of the cost was borne by the scholars and the remainder by the District Board, and the register enrollment was actually greater than in the year of the test experiment, 1910. Budaun is again doing the same in 1912.

In addition, Meerut in 1912 is running a similar experiment with 5,561 boys and 199 teachers, the greater proportion of the cost of this quinine being recovered from the boys by a small fee for enrollment on the quinine register. No compulsion is being used. Another feature of the Meerut experiment this year is a graduated scale of dosage to meet the potentialities of different localities. This has been circulated to all Head Masters throughout the district, and, as the distribution is in the hands of the masters, an attempt has thus been made to get at Khadir and outlying schools which would otherwise be beyond a special distributor's help. The energetic Secretary of the District Board in Meerut is responsible for this innovation.

Aligarh and Muzaffarnagar are also carrying out register distribution on systematic lines this year at their own expense; while three other districts are running modified experiments.

The popularity of these measures in severely affected tracts is undoubted, as on several occasions requests were made to have the distribution continued for another month after the date fixed for the completion of the test.

Conclusion.— It will thus be seen that as sickness from malaria is among the most frequent causes of irregular school attendance in the rainy season, as with reliable uncoated tablets of quinine we have an elegant and exact means of administering a preventitive and curative, as during 1910 and 1911 we have demonstrated in three carefully applied tests its feasibility, its educative value both to scholar and to the home circle, its salutary value both to uninfected children

and to children already infected, its comparative cheapness and its prevention of irregular school attendance, school quininisation, as a general measure, has now passed the experimental stage, and the principle of its applicability for all district schools of the United Provinces and similarly affected areas during the rainy and fever season should now be accepted. That many districts may require less than others, and in some years none at all, is quite intelligible ; but, once the principle has been accepted, individual districts, with the expert advice of their Civil Surgeons and others, could easily determine how far the principle should be applied.

The details of these reports should not blind district authorities to the fact that the mechanism is neither complicated nor expensive, that it can and has been conducted by district authorities for an entire season without any outside help, and that to obtain from it the maximum of benefit, continuity from year to year in the same district is requisite.

MALARIA IN ITALY DURING 1910.

By Professor A. Celli.

(Translated from the original by Major N. P. O'Gorman Lalor, M.B., D.P.H., I.M.S., Special Malaria Officer, Burma).

PREFACE BY THE TRANSLATOR.

No one who reads this thesis can, the translator ventures to think, avoid the conclusion, that it represents one of the most important contributions which have been made within recent years towards the practical solution of the malarial problem.

Its distinguished author by abundant testimony conclusively proves :—

(1) That quinine taken at an approximate daily rate of three grains in the morning, and three at night, throughout the fever season by a healthy individual in a severely stricken malarial locality, practically guarantees him against the risk of malarial infection.

(2) That quinine similarly consumed by every individual—whether presumably healthy or malarially suspect—in a malarial community, affords similar and proportional guarantee as regards the community.

(3) That quinine taken in the prophylactic quantity mentioned, is absolutely devoid of harmful effect, proximate or remote, to the consumer.

(4) That the risks to which subjects of chronic malarial infection are said to be exposed by daily quinine consumption, *viz* :—

(*a*) Intracorporeal development of haemamaebic types resistent to quinine (Chininfasten—malaria parasiten) and

(*b*) Quinine haemoglobin urea,

are assuming smaller and smaller proportions with our increase of knowledge, and are probably non-existent when quinine is taken with perfect regularity.

(5) That there is at present but one preparation of quinine suitable for administration to young children—the tannate—and that it is best administered made into a sweetmeat with chocolate. (This latter suggestion unfortunately cannot be utilised under Indian climatic conditions.)

He predicts a final triumph for prophylactic quinine which will transcend in its significance the claims he so clearly substantiates for it at present, and incidentally he discredits mosquito-destruction methods as ineffective.

Professor Celli's presentation of this last conclusion is so dazzling at first sight that, to preserve an even judgment, it is necessary to view it in perspective. With regard to the practical problem of malarial extermination there are at present two schools of thought.

The Anglo-American school, taking justifiable stand upon the brilliant results achieved by mosquito-destruction methods in the Suez and Isthmian Canal Zones, is inclined to give mosquito-destruction methods perhaps undue prominence.

The continental school, following the brilliant results attained by quinine prophylaxis in Italy, is inclined to pin its faith exclusively to that measure.

For either method to be exclusively applicable, it would have to be proved—(*a*) that it is intrinsically perfect, (*b*) that it is perfectly adaptable in all practical circumstances.

As regards mosquito-destruction if we neglect accidental but important factors, such as the opportunities afforded by the *centripetal movements of industrial labour* for multiple infection from a single anopheline carrier (for example by

a crowded coolie barrack), we should expect the intrinsic perfection of the method to be governed by certain axioms. These might be expressed as follows:—

(1) The number of anopheles of malaria-carrying species in a locality should bear a constant ratio to the superficial area of the water collections in which anopheles of that species breed.

(2) If the area of such collections be reduced, the number of such anopheles should be reduced in corresponding proportion.

(3) The number of individual anopheline sprozoit carriers at the height of the fever season should bear a constant proportion in ordinary years to the total number of anopheles of the same local species.

(4) Diminution in the number of local anopheles of malaria-carrying species should—as a consequence of the preceding axioms—be accompanied by corresponding reduction in cases of human malarial infection.

The life history of anopheles and its rôle in malaria are not susceptible of such simple axiomatic presentation as this.

As regards the Prophylactic use of quinine—if we neglect to consider that *centrifugal tendency of agricultural labour*, which tends constantly to carry individual labourers out of the zone of prophylactic operations—we should expect the intrinsic perfection of the method to be such, that once it had been pursued in a severely stricken malarial and stationary community to the point of practical disappearance of the disease in the human being, it could be completely and universally stopped without any risk of subsequent local recrudescence. Its continued use should in fact have converted the area from a malarial into a healthy one.

Professor Celli himself would hesitate to claim so much for prophylactic quinine *at present*.

Neither method, therefore, so far as we at present know, is intrinsically perfect. How much less is either method perfectly adaptable in all practical circumstances. There is—to employ a mathematical metaphor— a fourth dimension to the malarial problem; and its attribution to "those laws of cyclical revolution which dominate the biological field" is devoid of immediate practical corollary.

With reason therefore has the translator asserted that "no single measure is by itself effective in reducing the ravages of malaria amongst fever-stricken populations". (Investigation of Malaria at Kyaukpyu, page 25).

We are not within measurable distance in India of the voluntary acceptation of prophylactic quinine by the people, even to the extent—defective as Professor Celli shows—to which it obtains in Italy.

There is in India an influential body of interested quasi-professional public opinion, supported by the more reactionary (not always unfortunately the least educated) amongst the people. This opinion is actively hostile to the use of quinine, even in the treatment of malarial fevers—much more to its use in their prevention. It is recruited from the ranks of practitioners of old and obsolete systems of medicine which, devoid of accurate scientific basis, are as remarkable for the poverty of their results in general, as they are for astounding and semi-miraculous cures in particular; cures which unsupported by published circumstantial detail, and devoid of a shred of scientific proof, are conveyed from mouth to mouth on hearsay evidence.

Professor Celli contrasts the prophylactic use of quinine with what is termed in Italy, its use in 'human reclamation'; that is to say in the inter-epidemic treatment of fever subjects, chronics and the malarially suspect. This use of quinine, confined to inter-epidemic periods, is foreign to Indian conception.

The translator has advocated the prompt and continuous treatment with quinine of malarial subjects acute or chronic (including children who present splenic enlargement) all the year round and *especially during the fever season*. This he has termed 'Quinine phylaxis'—and it does not appear from Professor Celli's account that this method of using the drug (the most thorough method as regards the general population at present feasible in India) has been condemned in Italy.

So far as extending the use of quinine is concerned, we are confined in India to active educational propagandism, to the employment of travelling dispensaries in malarial tracts, and the placing of quinine—in a cheap and reliable form—within universal reach of people who choose to avail themselves of its benefits.

Unable to give practical effect to the conclusions of Professor Celli with regard to quinine prophylaxis, we are constrained in India and Burma to take a wider and more catholic view of the malarial problem; welcoming, not one alone, but all means suggested for its solution, and employing these in suitable and varying combination.

In Italy, while the universal use of prophylactic quinine appears increasingly feasible, the proscription of cultivation within a defined area surrounding towns and villages would appear to be more difficult. In India, while the first of these measures is not within measurable distance of realization, the second is susceptible of wider application. In a word, we are obliged to adopt in India and Burma, a width of view as regards the malarial problem, proportional to the vast size of the Indian peninsula and the immense variations to be found, as regards malarious places, in the topographical and economic conditions under which the people live.

But there is no worker, however humble, in the Indian malarial field, who can fail to feel deeply indebted to Professor Celli for this masterly contribution to the practical solution of the malarial problem. We have been taught to expect nothing less from the Professor's able pen, and by its exercise on this occasion our expectations are fully gratified.

MALARIA IN ITALY DURING 1910.

Professor Celli.

(Published by the Italian Society for Malarial Research.)

PART I.

EPIDEMIOLOGY OF MALARIA.

1. *General History.*—During 1910 the periodic recrudescence which started in 1909, continued in the Venetian Estuary, in the Veronese flats, in the district of Grosseto, in the Pontine marshes, and particularly in the district of Crotona where certain localities (Crucoli Ciro, etc.) became vast hospitals, so to speak, of the malaria stricken; on the other hand it underwent diminution to some extent in the Roman plain, and ceased in the district of lower Polese.

Speaking generally the annual fever season of 1910 was mild in the south (districts of Benevento, Puglie, divisions of Cosenza, and Reggio Calabria). It was correspondingly mild in Sicily and Sardinia.

Progressive diminution almost ending in disappearance of malaria continued likewise in the districts of Vercelli and Novara in Lombardy, and even in the city of Mantua which ten years ago was scourged with the disease. Where the year was one of more serious prevalence, it is nevertheless possible to assert that this was much less the case in several localities where the anti-malarial operations of our society were assiduously and energetically carried on. From a comparative international standpoint, although we have some partial and localised recrudescence (Orano Railway), malaria was milder in Algeria than in 1909, as was the case with us all over the south and in the islands.

In Greece also following the recrudescence of 1905 intensity of prevalence descending by regular stages through latter years reached a minimum of 170 deaths only in 1910. In some localities there was, however, a limited recrudescence. It is worthy of remark that in north-west Germany certain foci of malaria which at the end of the last century appeared spent, have awakened to fresh activity during the last decennium.

Some further light has been thrown on the history of malaria in the past. According to Doctors Messineo and Mazzolani, the periodic recrudescences characteristic of past times, are starting afresh in the Fondi plain as far as the confines of the Pontine marshes, and the same is true according to Professor G. Rossi of the site of the former Fucino lake and of the maritime zone of Macerata Division, which up to the present have been numbered amongst the areas exempt from malaria.

2. *Aetiology. Diagnosis of latent infection.*—In the most infected zones of Bulgaria near the Black-sea the parasitic distribution was as follows:—

Aestivo-autumnal	51 per cent.
Simple tertian	48 ,,
Quartan	2 ,,

* * * * * * *

In Sicily (Caltanisetta) Doctor Janni confirms the more or less long latency of plasmodia of primitive infection, in individuals according to all clinical appearance exempt. He asserts moreover the discovery of the parasite in the blood at suppurative foci (acute and chronic abscesses) even when absent or very rare in the peripheral circulation, and he finds it especially in individuals at the clinical

fastigium of non-malarial fevers, under which circumstances it appears to lead a saprophytic life, becoming at the same time less subject to the influence of specific remedy.

Doctor Barbagallo in Sicily (Catanian plain) commonly observed in residents of malarial places at intervals severe hemicrania, intercostal neuralgia, lumbago, or pains in the bones for some hours, accompanied by general malaise, nausea, and exhaustion, but without any fever. In this way the strongest of men might be seen to become anæmic while afebrile, if through absence of fever he had no recourse to a medical man, or consulted the latter only when overwhelming debility compelled him. Especially at the height of these disturbances was it possible to find some æstivo-autumnal parasites in the peripheral blood.

Such cases may be more common than they appear, and although they attract no attention, are all the same a dangerous nursery for the perpetuity of the disease.

In Sardinia it is confirmed that sick admitted for severe malarial fever may be affected instead with single or mixed melitensis or other infections in the proportion of 33·33 per cent. of a total or of 92 sick who were examined bacteriologically.

Fermi and Lumbau in their turn have repeated their experimental research as to whether anopheles can transmit malaria without being infected from the blood of man, and whether they can transmit it after having bitten animals (bats, birds, and amphibians). The results in both cases continue to be negative. The hypothesis was also reasserted (Janni) but not demonstrated, of direct inoculation through the bite of domestic blood-sucking insects (fleas and bed bugs), such as happens after puncture by a needle smeared with malarial blood.

3. *Relapses in Malarial Fever.*—According to Frongia in Sardinian miners the subjects of lead poisoning, there is a latent malaria which breaks out in the form of relapse during an attack of lead poisoning.

4. *Annual course of Primary and Relapsing Fevers. Annual epidemic types.*—Whilst in the province of Catania especially in the Crotona district during 1910, the south Italian or severe malarial type persisted,—in the neighbouring division of Reggio Calabria the north Italian or mild malarial type was uniformly more marked; this latter statement is even more true of Sicily and Sardinia.

In those of our large islands which are very hilly with sparse stretches of level ground, the south Italian type has become increasingly rare in latter years. To this fortunate result the increasingly extensive use of State quinine must have contributed in no small degree, since it was especially marked during the seasons of periodic recrudescence of the disease.

5. *Bionomics of the mosquito in relation to Malarial prevalence.*—Doctor Casu after very accurate study over an extensive period at the lagoon of Santa Gilla near Cagliari, has written a preliminary essay on 'botany in its relation to anopheline fauna,' in which is comprised a minute investigation of the marsh flora of fresh and of some brackish waters.

Marsh plants and anopheles larvæ are sociologically related organisms; but the first can live in the absence of the second in collections of brackish water in virtue of their greater saline resistance, and are not therefore, in the absence of other evidence, an index of malarial paludism.

On the contrary they become gradually less with the approach of the summer season. This is the very season of fever, despite more intense and energetic evaporations of fresh water and contraction of streams flowing into the lagoon; both of which causes increase the saline content, and destroy or suspend anopheline aquatic life. Professor G. Rossi with characteristic diligence has described two zones which were for many ages malarial, *viz.*, the ex-lake Fucino and the valleys of Loreto and Resanati; the last periodic recrudescence in the two latter was between 1850 and 1876; these now furnish typical examples of paludism and anophelism without malaria. In Algeria the zone or radius of propagation of malaria across flat country—that is to say of mosquitoes in direct flight uninfluenced by wind or other agency—varied from 1 to 4 kilometres according to locality.

The suggestion of a 'zone of influence' with respect to estates and surrounding habitations—be it deleterious (as in the case of marshes) or beneficial (as in the case of combined water power and irrigation works)—again arises, and gives occasion for arduous controversy, especially with regard to the working of our laws of bonificazione. Evidently therefore it is necessary to treat each case as an individual one, and with but approximate hope of accuracy.

6. *Relation between infection of Anopheles and Malarial prevalence.*—According to Mathis and Leger, not only Myzomyia (Nyssomyzomyia—James and Liston) Rossi, but also Myzorhynchus Sinensis pseudopictus, and Myzorhynchus Punctulatus (Nyssomyzomyia Punctulata—James and Liston) are not infected by sucking malarial blood, and accordingly take little or no part in originating or conveying malaria. Their prevalence would thus explain anophelism with little or no malaria—in marshy localities, in the rice cultivation of the Cochin-China delta and, according to Mazzolani, also in Yunnan. In our rice fields of Piedmont and Lombardy where malaria is disappearing, Anopheles Claviger has for long outnumbered Superpictus, and it would be interesting by conducting more accurate experiments to determine the infectivity or otherwise of this mosquito.

7. *Agriculture and Malaria.*—In the Division of Reggio Calabria it is established that intensive cultivation in no degree lessens malarial prevalence, but on the contrary sometimes increases it when no regulations are made at irrigation works (a matter not always easy or useful) to secure the drying out of all pools, and the protection of labourers and night inspectors.

More rational cultivation in marshy localities limits or reduces anophelic influence only in part, and though it proves beneficial—whether because of better nutrition arising from more abundant and varied products of the soil, or because of the possession of house, and clothing, with a less precarious mode of life—it fails, notwithstanding, by such indirect means to preserve man from malaria, unless prompt and immediate medical—especially quinine—prophylaxis comes to the rescue. *Emigrant agricultural labour* furnishes the sole explanation of deleterious influence in the diffusion of malaria in areas usually immune, as well as in stretches of extensive cultivation, or tillage wastes. Doctor Sinisi records with Aleardi that in Tavoliere delle Puglie as in our Pontine marshes:—

> "The mowers come in thousands, as the pangs
> Of cruel hunger urge their footsteps on.
> Their aspect is of those who go in gangs
> To exile, and their faces sad and wan
> Keep mournful company with the tears that dim
> Their brown eyes, as they breathe the poisoned air
> Some voices stilling ere the Harvest Hymn."

And the gleaners—without shelter, without sufficient food, without any quinine, and subjected to the hardest conceivable privations—are worse off again than the mowers.

Doctor Colucci confirms the statement that the peasants of Puglie are especially harassed by malaria, owing to the custom they have of repairing for the mowing and threshing season to Calabria and Basilicata, where—herded in groups of 50 to 100 or more—they sleep in the open after days of strenuous labour, with every risk of contagion. As railway medical officer he aided for over five years the periodic summer autumn passage through the station of Metaponto of these herds of human flesh conveyed in holocaust to fever.

As regards the relation between Climatology and Malaria it is found here in Lazio that the torrential Sirocco spring rains are not a necessary prelude to, nor do they intensify the summer fever season; further—and this is especially true of Algeria—that the autumn epidemic is usually prolonged if hot weather lasts till December.

According to Memmi in the district of Grosseto ameliorated economic conditions do not confer even relative comfort upon the agricultural labourer, and accordingly fail to react beneficially upon epidemic paludism.

The same may be said of other malarial regions where increase in daily wages has been neutralized by rise in the price of food stuffs, and in every case is powerless to modify the economic distress of our peasantry, especially in the great tillage wastes.

8. *Other predisposing causes of Epidemic Malaria.*—Commencing with *organic conditions*, it has been freshly observed in Cochin-China that all races are subject to malaria. Some however (Thais) become accustomed to paludal surroundings in the sense not of true and undoubted immunity, but of faculty of supporting the presence of plasmodia in saprophytic guise; that is to say without production by the latter of any pyrogenic or cachectic effect.

As regards the labourer it is established that miners, especially those of subterranean galleries, are more affected with malaria than agricultural labourers.

The facts are exhibited in the following table (after Frongia).

TABLE I.

Malaria in the Miners of Sardinia.

Years.	Mortality ‰.		Morbility %.	
	Agricultural labourers.	Miners.	Agricultural labourers.	Miners.
1904	0·2	1·38	7·6	20·0
1905	0·2	1·11	11·6	19·1
1906	0·2	1·38	4·3	30·5
1907	0·4	1·11	1·8	30·3
1908	0·4	1·11	1·5	25·1
1909	0·2	1·11	2·8	19·1
1910	0·2	1·11	2·4	6·0

In Sicily on the contrary there are fewer cases of malaria amongst the sulphur miners than amongst the peasantry of the same locality. It is not therefore improbable that lead poisoning to which the Sardinian miners are more or less subject, predisposes them to malaria more than does subterranean labour *per se.*

9. *Periodic course of Epidemic Malaria.*—In the district of Vercelli, Northern Italy, recrudescence continued, almost ending in disappearance of malaria.

* * * * * * *

A similiar state of things obtained in Lombardy. * * *

On the other hand in the division of Southern Venice the periodic decennial recrudescence continued.

Tuscan Marshes.

The periodic recrudescence in the district of Grosseto which was noted in the reports of the two years preceding that under review persisted in 1910, with 653 admissions to hospital.

Lazio.

In Lazio—more especially in the Roman Campagna—the epidemic recrudescence which started in 1908, lessened in 1910 both in distribution and intensity, with a smaller number of cases of fever (only 1,775).

In the Pontine marshes on the other hand, the periodic recrudescence maintained about the same level as that of the preceding year.

Southern Continental Italy.

Unfortunately of precise data for some years in succession, only those of the Marcianise Hospital can be quoted. There the number of malarial patients from 8 in 1908, and 96 in 1909, rose to 117 in 1910; hence the slight recrudescence.

In contradistinction to all other parts of the southern mainland recrudescence persisted in the district of Crotona.

Italian Islands.

The ever authoritative accounts of Professors Trambusti, and the reports collected from our members, agree in stating that the epidemic of the past year was relatively mild throughout Sicily.

The accounts of the 'Cagliari Society for Malarial Defence,' and of the Medical officers of the Royal and of Company railways, agree that—with the exception of some local recrudescence—malaria throughout Sardinia continued mild in type, though somewhat extensive in distribution.

10. *Epidemiological Conclusions.*—Whilst epidemic malaria as recorded for 1910 was progressively lighter in Vercelli and Lombardy, and continued mild but somewhat diffused in South Sicily and Sardinia the exacerbation of the preceding year continued in Lower Venice, Grosseto, and particularly in Crotona, where in some places (Crucoli Ciro) it attained graver pandemic proportions.

Concealed carriers of plasmodia were met with more frequently in general than might have been expected; to confine attention therefore to the fever stricken, the chronically affected, and suspects only (even were it easy to diagnose and cure the latter), could not bring about the extirpation of malaria.

It is otherwise confirmed that the mosquito is not infected after biting animals the subjects of infection by hæmosporidia which resemble those of man, nor is the latter infected by the simple bite of an insect which has fed on malarial blood. The annual epidemic type or cycle peculiar to mild malaria (North Italy) shows a tendency to spread over the southern mainland and littoral (Reggio-Calabria), and also throughout the islands; not merely in consequence of spontaneous periodic attenuation, but—as we shall see—especially in virtue of the issue of quinine by the State.

From the flats of Polese, to Calabria and Sicily, it is reconfirmed that agriculture—even the most intensive—does not prevent periodic malarial recrudescence, and as a rule arrests neither its gravity nor its diffusibility, which are on the other hand, tenaciously maintained by the emigration of peasants from localities which are healthy to those which are febrile, and *vice versa.*

Increase in the wage of agricultural labour, contemporaneous as it was with rise in the price of foodstuffs, and unaccompanied in areas subject to grave malaria, by improved conditions of housing and farm life, has contributed in no way to diminish the epidemic prevalence of the disease.

The periodic type or cycle of epidemic prevalence exhibits a general tendency towards attenuation, and only where it exists disproportionately (Lower Venice, Grosseto, Crotona) does it tend towards recrudescence.

Through a mechanism ever obscure in its intimate nature, but in all probability in virtue of the marvellous intrinsic properties of the living protoplasm, especially that of specific protozoa, much more than through eventual concomitance of such extrinsic factors as climate, etc., cyclical laws or laws of revolution dominate the field of malaria, as they do that of all biology, and govern every single febrile manifestation equally with every epidemic type, annual or periodic.

As in every febrile attack, so in every annual or periodic epidemic, there are two phases, one of ascent and one of descent.

It is necessary to keep most exact account both of the cycle and of its two phases, so as to be able not only to estimate the efficacy of every anti-febrile remedy, but also to assign just value to each of our prophylactic and anti-epidemic measures.

PART II.

PROPHYLAXIS OF MALARIA.

In the past year 1910 again we were specially engaged in propagating and spreading quinine prophylaxis; but as usual we did not neglect the study of other methods of freeing an area from malaria, especially reclamation by combined water power and irrigation works.

I shall first refer to the results obtained, and I shall then draw certain conclusions.

A.—STATE QUININE.

This provident institution of ours resulted in a consumption (*vide* Table III) of the precious drug in various forms (tablets, sweets, sterilized phials) which from 2,242 kilos in the first financial year 1902-03, rose to 6,174 in the second year, to 14,061 in the third, 18,698 in the fourth, 20,715 in the fifth, 24,139 in the sixth; fell to 23,553 kilos in 1908-09, to 21,629 in 1909-10, and again rose to 22,795 kilos in 1910-11.

Private enterprise continued the sale of quinine in 1910 importing into Italy 13,011 kilos. It is here advisable to state according to divisions for the financial period commencing with July 1st, 1909, and ending on the 30th of June 1910:—

TABLE II.

The Consumption of State quinine.

Serial No.	Name of Division.	Total consumption in kilos.	Consumption in grammes per person.	Increase or decrease compared with the year preceding.
1	Piemonte	1,526·780	0·437	— 0·064
2	Liguria	61·270	0·050	— 0·004
3	Lombardia	1,889·975	0·406	— 0·055
4	Veneto	2,080·925	0·594	+ 0·003
5	Emilia	442·560	0·172	— 0·022
6	Toscana	325·255	0·119	— 0·005
7	Marche	14·540	0·013	+ 0·001
8	Umbria	20·840	0·029	— 0·020
9	Lazio	(a) 1,372·645	1·022	— 0·004
10	Abruzzoe Molise	537·340	0·359	— 0·074
11	Campania	1,283·065	0·390	— 0·086
12	Puglie	2,345·000	1·103	+ 0·048
13	Basilicata	913·650	1·912	— 0·012
14	Calabrie	1,915·770	1·323	+ 0·096
15	Sicilia	2,945·765	0·819	— 0·204
16	Sardegna	1,753·220	2·012	+ 0·111
	Total	19,429·600	0·562	— 0·034

(a) Exclusive of 2,200 kilos purchased at Rome for all the State Railways.

The divisions therefore whose total consumption of State quinine was greatest in 1910 were in descending order: Sicily, Puglia, Venice, Calabria, Lombardy, Sardinia, Piedmont, Lazio and Campania; but as regards quantity consumed per inhabitant were in descending order: Sardinia, Basilicata, Calabria, Puglia, Lazio and Sicily.

Sardinia, Calabria, Puglia, Venice and Marche show an increase in consumption during 1909-10, compared with that of the preceding financial period; the rest show decrease.

In comparison with the preceding financial period consumption increased in sixteen districts and diminished in the remaining fifty-three.

The greatest increase (507 grammes) was in the district of Reggio Calabria, the greatest diminution (843 grammes) took place in the district of Trapani. Important diminutions took place also in divers other districts notorious for the gravity and persistence of endemic malaria.

The figures above quoted when compared with the divisional geography of malarial mortality, again warn us that in some divisions there is not even yet consumed as much quinine as is necessary to reduce malarial mortality to a minimum; and since as we shall see the malarial sick rate has not been notably diminished even in places where malarial mortality has been reduced, we must conclude that for the further reduction of both one and the other the consumption of quinine should be increased.

As a compensating piece of good fortune, it is authoritatively stated that the use of our State quinine in its various forms, sugarcoated chlorhydrate and bisulphate, phials for injection, and tannate covered with chocolate—has spread to Greece and Bulgaria. These last products of our State factory were again in 1910, by unanimous medical opinion, proclaimed most useful and indeed indispensable, especially in combating infantile malaria.

To commence with foreign testimony, I would mention that the Austrian Government has made a point of adding to its other State quinine products, chocolates in the form of small discoids, which are pleasant to the taste and contain 10 cgrs. of tannate of quinine each.

In the French Colonies, Dr. A. Thiroux tried the tannate on Senegalese infants, found it well tolerated, and in doses of 60 to 85 cgrs.—as efficacious as the chlorhydrate. Several cases of dysentery in malarial subjects rapidly improved by the use of this remedy. For Germany, Werner asseverates that the tannate, devoid as it is of bitter taste, is extremely advantageous for children.

For Greece, Savas reconfirms the statement that "chocolates are particularly recommended for the prophylaxis and treatment of children."

For Bulgaria, Dr. Bourmoff states that though they are dear in price, they are nevertheless *indispensable* weapons in the anti-malarial armoury, whether for the prophylaxis, or for the cure of infants.

Of evidence available from one extremity of Italy to the other, I content myself with quoting the following:—According to Dr. Mayer of Donada, chocolates were of great assistance in the cure of younger infants, to whom other preparations of quinine are impossible of administration; they are always welcomed, and very well tolerated, and show themselves especially efficacious in malarial fevers complicated by gastro-intestinal disturbances. At Grosseto, Professor Memmi and Dr. Fusci employ tannate chocolates in infantile therapy, and accord them uniform praise in every respect.

In the Roman and Pontine Campagna, the health officers of Rome and doctors of the Red Cross unanimously declare, that without tannate chocolates, they would be at a loss to devise means for the prophylaxis and cure of infants.

So also in Valforter (Benevento) according to Dr. G. Pelosi the prophylaxis and cure of malaria in early infancy was very difficult for want of these chocolates.

On the other hand according to Colucci the advantage of such preparations is beyond description; young children beg for them so insistently that at times it is necessary to be very strict in their distribution. In the district of Crotona which was one of the gravest centres of malaria in 1910, Dr. Rotondo, and Sabbatini, a student, treated 260 infants of Ciro Marina with chocolates during the months of July, August and September. Of these 82 received quinine in prophylactic strength, all with the happiest result, and 178 in curative strength; amongst these latter poor results followed in 26, medium results in 11 and excellent results in 141 cases.

In the Proceedings (of our Society) is quoted a case of adult idiosyncrasy to ordinary salts of quinine, in which however the tannate was tolerated, and proved beneficial.

At Crucoli in the district of Crotona itself Dr. d'Afflitto treated 350 infants with quinine tannate chocolates, and except in the gravest pernicious cases in which hypodermic injection was essential, the tannate triumphantly justified its therapeutic position.

Having had the opportunity of comparing the chocolate preparations of Erba with those of Martinotti I find the latter still a little bitter, and therefore less suitable for sick children. The brothers Sargent also complain that "the undeniable bitterness of the chocolatines obliges them invariably to prefer sugarcoated preparations." This defect however has now been removed, and the perfected article is actually a favoured object of greed with the more refractory amongst children, besides being an efficacious remedy, preventive and curative.

The Sicilian Red Cross also, finding itself unable to get along without chocolate preparations, appealed for them and received them as a gift from Queen Helena.

Dr. Vadala di Furnari and Dr. Maltese di Salemi, in their turn and on behalf of the Medical Officers of Health of towns in Sicily, reconfirm the view that the tannate affords the best means of combating malaria during the age of infancy.

Comparative trial was also made outside Itlay between chocolate preparations of the tannate and euquinine.

Thus in Germany, according to Muhlens, the tennate chocolates of the 'Maison Zimmer' were advantageously substituted in recent years, for the purpose of combating malaria in infants.

They were also adopted in the Argentine "for infants who took to them readily."

On the other hand in Italy, the euquinine placed on sale by the State quinine factory under orders from the Superior Council of Health is—as might easily have been foretold—reported a more crying failure than had been expected. Suffice to say that during the first financial period (October 1910—July 1911) only 196 kilos were sold, of which the first 100 kilos being the permanent advance stock of offices of resale,—and 35 kilos—made over to the Sanitary Department—have to be subtracted.

This means accordingly an actual sale of 61 kilos only. During the second financial period and more especially from July 1911 to January 1912, only 98 kilos were sold, of which 71 were made over to the Sanitary Department, and two were sold abroad. Hence a sale of only 25 kilos; a negligible amount for the whole of a summer-autumn epidemic season.

For the rest according to new and felicitous applications to pharmacology of the chemistry of colloids, we may now regard the tannate as a colloidal compound of tannin in watery solution, with a crystalline salt of quinine. On the other hand the researches of Almagia demonstrate how other colloidal substances (lecithin and cerebral substance) take away from quinine that organotropic or elective action which it exercises to the detriment of the nervous system (whence cardiac and respiratory depression, tremors, deafness, amaurosis) without damaging the parasitotropic or specific action of the drug.

The tannate is accordingly—in the modern chemotherapeutical sense—an ideal compound, inasmuch as it resembles the mechanism of which nature avails herself for transportation and transformation of all organic and mineral substances in the most hidden parts of the human organism. Hence on the whole there is room for believing that the Superior Council of Health will remove its veto, in frank recognition of new experience uniformly favourable to the tannate both at home and abroad, and of the failure of euquinine put on sale to no purpose for now close on two years.

B.—State Quinine and Mortality from Malaria.

In the first place I shall compare the consumption of State quinine since 1902, with mortality from malaria between 1900 and the present time.

TABLE III.

State quinine and mortality from Malaria in Italy.

Consumption of State Quinine.			Mortality from Malaria.	
Financial year.	Kilogrammes sold.	Net profits in Lire.	Calendar year.	Total deaths.
.....	...	...	1900	15,865
.....	...	...	1901	13,358
1902-03	2,242	34,000	1902	9,908
1903-04	7,234	183,038	1903	8,513
1904-05	14,071	183,382	1904	8,501
1905-06	18,712	296,295	1905	7,838
1906-07	20,723	462,280	1906	4,871
1907-08	24,351	700,052	1907	4,160
1908-09	23,635	769,809*	1908	3,463
1909-10	21,656	720,000*	1909	3,533
1910-11	22,795	843,312*	1910	3,619

* The profits from sale of State quinine abroad are included in these figures.

Between these two events—consumption of State quinine and malarial mortality—there is clearly a close relation.

In fact from 1902 to 1908 while consumption of quinine progressively increased, mortality from malaria continuously declined.

From 1908 to 1912 while quinine consumption remained stationary with slightly appreciable oscillations, the number of deaths from malaria—figuring about 3,500—was equally constant; remaining on the whole lower by four-fifths compared with 1900, and by two-thirds compared with 1902, the year with which the new State dispensation commenced.

* * * * *

It appears to demonstration especially that after the action of the State from 1902 on had doubled—as it quickly did—the total consumption of the precious drug, malarial mortality ceased to exhibit its more or less quinquennial periodic recrudescence, and entered into an entirely new phase of progressive and precipitous descent.

For the rest, to deny this intimate relation between the increase in the consumption of quinine, and the decline of malarial mortality and its recrudescences, would be tantamount to a denial of the sovereign value of the marvellous drug itself. No one, even of the most obstinate enemies—open or concealed—of the new State dispensation, has dared to go so far as this.

* * * * *

It is useful to compare malarial mortality with population for each division of the Kingdom, and for the Kingdom itself as a whole.

The results of such a comparison are exhibited in the following table :—

TABLE IV.—*Malarial Mortality per 10,000 inhabitants in each division of Italy and in Italy as a whole—from* 1887 *to* 1910.

Divisions.	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910
Piemonte ...	1·6	1·2	1·1	1·0	1·0	1·1	0·8	0·6	0·6	0·6	0·5	0·5	0·5	0·5	0·4	0·2	0·2	0·1	0·1	0·1	0·1	...	...	...
Liguria ...	0·4	0·3	0·3	0·2	0·3	0·2	0·2	0·2	0·2	0·2	0·1	0·1	0·1	0·1	0·1	0·1	...	...	...	...	...	0·1	...	...
Lombardia ...	1·1	0·9	1·0	0·9	0·9	1·1	0·9	0·8	0·7	0·6	0·5	0·7	0·7	0·5	0·5	0·4	0·3	0·2	0·2	0·1	0·1	0·1	0·1	...
Veneto ...	1·7	1·5	1·4	1·1	1·3	1·3	1·3	1·4	1·2	1·1	1·1	0·9	0·9	1·0	0·8	0·5	0·4	0·4	0·3	0·2	0·3	0·3	0·3	0·3
Emilia ...	1·3	1·0	1·0	1·0	1·3	1·1	1·3	1·0	0·8	0·9	0·9	1·0	0·9	0·9	0·8	0·6	0·4	0·3	0·4	0·1	0·2	0·1	0·1	...
Toscana ...	1·2	1·2	1·5	1·7	1·8	1·5	1·2	1·2	1·2	0·9	0·7	1·0	0·8	1·1	1·1	0·5	0·3	0·1	0·3	0·2	0·1	0·2	0·3	0·3
Marche ...	0·6	0·6	0·6	0·5	0·5	0·3	0·4	0·4	0·4	0·4	0·2	0·3	0·3	0·3	0·2	0·1	0·1	0·1	0·1	0·1	...	...	0·1	...
Umbria ...	1·1	1·0	1·5	1·5	1·1	0·9	0·8	0·7	0·8	0·9	0·4	0·3	0·5	0·7	0·4	0·2	0·1	0·1	0·2	0·1	0·1	0·2	0·1	...
Lazio ...	9·2	10·2	10·6	10·6	12·5	9·7	9·5	8·4	8·6	6·6	4·3	5·4	4·4	6·0	3·9	2·7	2·3	2·1	2·4	1·7	1·1	1·3	1·0	1·1
Abruzzie Molise	13·6	8·1	7·7	6·3	11·3	7·2	5·8	5·0	7·6	6·0	4·6	3·9	2·7	4·9	4·0	3·6	4·5	3·7	3·0	1·1	0·7	0·7	0·9	0·9
Campania ...	6·2	5·2	6·8	5·9	6·9	5·5	4·5	4·0	6·0	5·2	3·6	3·3	2·6	3·8	2·6	1·6	1·3	1·7	1·8	0·8	0·7	0·5	0·5	0·6
Puglie ...	16·1	9·4	9·0	10·9	12·7	12·0	12·7	10·2	14·1	13·2	10·2	8·9	7·5	14·7	14·1	10·4	9·5	9·3	7·7	3·9	3·5	2·5	2·4	3·0
Basilicata ...	24·6	12·5	15·4	17·8	24·0	18·4	18·1	17·7	26·6	19·7	14·9	11·6	11·1	23·3	17·6	14·1	11·5	15·8	17·4	6·6	4·9	3·7	3·5	3·6
Calabria ...	18·4	14·5	13·1	15·1	14·8	12·6	12·4	12·5	10·2	9·9	8·9	8·0	7·5	12·7	11·1	7·7	6·0	4·7	5·2	3·4	3·5	2·6	3·6	3·1
Sicilia ...	16·9	12·4	12·4	9·3	11·4	10·0	11·3	13·1	11·0	9·9	7·5	7·1	7·8	11·6	10·1	7·6	6·3	5·4	4·9	4·5	4·3	3·1	2·8	2·4
Sardegna ...	30·9	28·8	29·1	30·8	28·8	25·0	23·2	27·0	27·7	17·1	25·3	26·2	27·6	27·9	20·1	15·4	13·0	17·1	15·2	8·8	6·9	6·6	7·3	7·3
Regno ...	6·9	5·4	5·3	5·2	6·0	5·1	5·0	5·0	5·3	4·5	3·8	3·6	3·4	4·9	4·1	3·0	2·5	2·5	2·3	1·4	1·8	1·0	1·0	1·0

Here we have again *two malarial Italies*, the milder ending with Lazio, the graver from Lazio downwards.

Comparing further the proportional decrease of malarial mortality in areas from Lazio southwards, it is noteworthy that from 1887 to 1900—neglecting periodic oscillation—almost no spontaneous attenuation had been reached in Basilicata, very little in Sardinia, and still less in Sicily, Puglia, Calabria and Lazio ; and that whilst all benefited after 1900—in other words after the advent of State quinine—those divisions which were before the most severely and persistently malaria-stricken, benefited to a special degree.

For those of the divisions mentioned which with the most precipitous descent of malarial mortality received the maximum benefit from State quinine, it is advisable to examine particularly the trend during the years 1887-1910 of *mortality from pneumonia and enteritis*, two diseases which can aggravate and therefore exaggerate—or hide and therefore obscure the true significance of—malaria, in statistical tables of the causes of death.

TABLE V.—*Mortality per 10,000 inhabitants from Plumonitis and Enteritis in certain Divisions of Italy from* 1887 *to* 1910.

Divisions.	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910
								MORTALITY		FROM	PULMONITIS.													
Lazio	22	24	22	26	26	27	29	23	25	30	23	24	21	23	24	22	25	21	23	20	22	19	21	19
Puglie	31	31	22	26	27	25	28	28	32	34	24	27	25	24	32	30	30	26	25	24	23	21	19	21
Basilicata	38	35	26	34	30	32	30	30	34	37	23	26	25	26	27	28	32	24	27	26	24	21	19	19
Calabrie	25	33	24	32	28	27	25	31	30	28	24	25	26	27	23	24	27	20	21	21	23	21	21	18
Sicilia	17	25	21	26	23	21	23	23	30	24	19	20	20	23	22	20	22	19	13	19	22	20	20	22
Sardegna	18	22	24	30	26	27	22	25	29	26	25	24	26	26	25	26	20	29	27	24	21	21	25	21
								MORTALITY		FROM	ENTERITIS.													
Lazio	27	29	29	29	31	26	29	25	30	31	26	30	26	37	27	27	31	25	27	27	22	21	24	22
Puglie	45	47	49	47	56	50	51	52	58	61	50	60	48	60	32	60	54	56	59	50	53	45	50	48
Basilicata	49	44	45	45	54	51	45	55	58	63	43	50	39	57	43	56	47	50	50	44	45	42	40	43
Calabrie	34	37	33	35	38	38	43	47	44	43	37	38	37	48	34	38	35	34	34	34	31	29	31	28
Sicilia	45	47	44	47	52	50	48	52	48	50	42	51	46	55	46	53	47	46	49	48	43	39	44	38
Sardegna	24	23	24	24	25	24	25	27	29	28	30	32	32	29	25	27	26	33	36	30	32	28	32	28

So that it appears very clearly—in fact to demonstration—that from 1887 on, in spite of some irregular periodic oscillation, pulmonitis underwent no diminution in Lazio, Sicily, and Sardinia, and but the slightest in Puglia and Calabria; whilst enteritis increased in Sardinia, and was elsewhere stationary. Thus the aforementioned decrease of mortality from malaria is thrown into clearer relief, because unobscured by errors in the classification of deaths from dual causes.

Hence no one can any longer cast doubt upon the conclusion that the very great and continued fall of malarial mortality since 1902 has been principally due to increased consumption of State quinine.

C.—Radical cure of Malarial Infection.

Dr. Tuveri as a result of prompt and assiduous treatment of 3,736 malarial patients since 1904 in a circumscribed area of Sardinia, witnessed 36 per cent. of cures (*i.e.*, of cases in which there was no relapse) after small and frequently repeated curative doses, 20 per cent. of cures after larger and more prolonged dosage (12 per cent. after the third, and 7 per cent. after the fourth relapse), and 22 per cent. of persistent relapses in spite of all treatment.

For such cases as these last it is useless to expect better health from treatment other than quinine treatment. With good reason therefore has Professor Memmi abandoned in Grosseto Hospital the advocacy of preparations of arsenic and iron—even in patients in a condition of marked anæmia, because he is convinced that these remedies do not improve blood formation to any greater extent than quinine by itself improves it.

Hence, in place of clinging obstinately to a blind trust in that ancient and rusty arsenical treatment which was started in Lazio at the beginning of the latter half of last century by Drs. Jacquet and Minzi, and in the Tuscan marshes by Salvagnoli-Marchetti, it behoves us to have recourse to chemical and experimental study with the object of discovering in this palmy age of chemotherapy, a remedy possibly more efficacious than quinine; especially against those forms which nature is careful to safeguard for the purpose of better insuring the conservation of species.

Meantime '606' has established its activity as regards only the plasmodium simple tertian, which is easier of destruction but, on the other hand, is inactive against the plasmodium of Summer-Autumn fever.

D.—Sanatoria for the Malaria-Stricken.

Persisting in the aim of so-called human reclamation a few philanthropists established further sanatoria during 1910 at climatic resorts: one at Montichio Sul Vulture for 20 young children of Basilicata; others on the hills at Sila and Ferdinandea for a few children of Calabria; another above Messina in the Cammaro forest.

With regard to the last Professor Gabbi has recorded that of 25 children admitted between August and October, 17 left the Sanatorium cured of splenic enlargement, without parasites in the blood, and with notable improvement in the condition of the latter. But how many of these were ætiologically cured and how many had acquired immunity consequent on climatic and therapeutic cure? And what of the other 8 children who, despite all sanatorial treatment, were not cured?

Neglecting these considerations, however, if we analyse—as we can and must—the epidemic causes at work, to what extent could the removal and cure of a few tiny carriers of plasmodia benefit Basilicata, Calabria, and the district of Messina?

Professor Trambusti has furnished a well attested sanitary report, accompanied by an accurate financial statement from Commandatore V. Spartaro, regarding another anti-malarial sanatorium of Sicily which was at work during the past year.

From this it appears that of 86 admitted in 1910 but 19 were clinically cured = 22 per cent., 58 improved = 66 per cent., 5 remained unchanged (4 per cent.) and 5 died.

The result is therefore quite the opposite of brilliant although for the foundation of this sanatorium, and for the admission of 44 malarial chronics in 1909, and 86 in 1910, no less than 18,396 lire were spent under economical management.

This works out at 144 lire per head for each recovery—a sum which would suffice to purchase for a full 47 individuals during six months of epidemic enough quinine for prophylaxis, that is to say for the prevention of reinfection and of lapse into the status chronicus (this use of quinine is suitably defined by the term "Phylaxis" trans.). On behalf of Dr. Evoli, who in 1909 was the first to establish a sanatorium on the hill of Aspromonte, Dr. Timpano fully endorses the opinion that "the sanatorium is an expensive luxury."

Much more is this the case in the South and in the islands where even the simplest and least expensive dispensary aid is wanting, and where for lack of quinine so many still die, and so many more sicken from malaria.

Still less is such expense justifiable in the case of children, since the fading of Koch's rosy hypothesis which attributed to children the principal role as chronic carriers of the malarial germ.

Even were his hypothesis true, in place of taking the children from their mothers and the surroundings in which they are born and have to live, and subjecting them to an exceptional as well as temporary mode of life, it would surely be much easier and less costly to amuse and quiet them with good chocolate preparations, by aid of which if sick they recover sooner than adults, and with a little maternal solicitude guided by medical advice do not fall ill at all.

Even if we neglect for a moment to consider the hereditary apathy of our people in malarious places, we cannot deceive ourselves with regard to the *educative effects of the sanatorium* to the extent of supposing that young children who have been drilled to take quinine, continue to take it after they return to their homes and set a good example to the family.

Towards such an educational sanitary goal we are directing and must continue to direct the school.

But the removal from epidemic surroundings here and there with so many precautions of a few tens out of many thousands of infected and infecting children, leaving all malarial adults—with their much more dangerous nomadism—undisturbed, bears too close a resemblance to our numerous and discredited reclamation works which paused at no expense to open a few drainage canals and raise some dams, but left behind them so much paludism and corresponding malaria. For the rest, did it suffice to remove only the more obstinate and rebellious chronics in order to dry up (*quod est in votis*) the sources of malarial infection, it is now the unanimous judgment of doctors of the Red Cross, and of Medical Officers of Health and Hospital Physicians of Rome that after a few years of general cinchonisation—without recourse to the inconvenience, trouble and expense of any sanatorium—those old cachectics the enduring and squalid evidence of chronic endemicity, would disappear from the plains of Rome, and from the Pontine marshes (and the same is also true of other places).

And now when quinine is gratuitous, to allow more to reach the cachectic stage would be—and is—a double crime.

In fine it has for some time been noted by us—as it has been in the colonies—that mountain climates do not exercise a particularly beneficial effect upon latent malaria.

On the contrary we plainly perceive fever declaring itself, so to speak, at mountain resorts in individuals who have remained well in the plains, persisting obstinately in spite of specific treatment, and sometimes ceasing only on return to the place where it was contracted.

In the fight against tuberculosis—in subduing which quinine is of no avail—it is possible from the records of thousands of German friendly societies to justify

mountain sanatoria, but without anything like the enthusiasm which attended their first establishment.

In fighting malaria however it is better instead of wasting pity and funds in the indulgence of private charitable eccentricity, to concentrate united effort upon that wider and truer social foresight, which by opportunely and energetically promoting—through the medium of hygienic education and sanitary organization—the diffusion of quinine prophylaxis is paving the way to the prevention rather than to the cure of malaria.

E.—Inter-and pre-epidemic treatment of Relapsing Malaria, the so-called "Human Reclamation."

In conformity with the opinions of the pathologists and clinicians of our Superior Council of Health—opinions be it remarked, to exclusively therapeutic—a staff for interepidemic treatment was entertained for the first time in the Pontine marshes from the 16th of December 1909 to the 15th of June 1910 out of funds provided by the Quinine State Factory. During this period 2,287 malarial patients were treated assiduously. Nevertheless in the ensuing fever season of 1910 so little inprovement was exhibited that the number of those attacked during the periodic recrudescence showed an increase of 7·6 per cent. as it did in the years 1906-07 before inter-expidemic treatment had been heard of.

Again at Bova Marina in the district of Reggio Calabria, 105 malarial patients were treated with quinine and so-called reconstituents (iron, arsenic, iodine, phosphorus) during the winter of 1909 and spring of 1910. But every few of these can be said to have been cured even clinically, 88 improved, 17 showed no improvement whatever; and after this so-called "inter-epidemic human reclamation" the epidemic was no less than it would have been had the practice of quinine prophylaxis alone been steadily continued during the epidemic period. Again in Sicily, under the assiduous and wise guidance of Professor Trambusti as much zeal was expended, as reliance was placed, in inter-epidemic treatment by the exhibition in addition to quinine of Baccelli's mixure with arsenic and iron in pill form especially for the more anæmic, in whom injections of methylarsenate of iron were also tried individually. And yet by the end of June after these energetic measures had been pursued for several months, the number of those clinically cured in various localities varied from 50 to 70 per cent. and the clinical benefit (reduction of spleen, afebrile condition, improved blood formation and general nutrition) assuredly did not amount to radical cure of the latent infection.

Hence unfortunately, as Trambusti states, "the number of uncured malaria chronics still continued high notwithstanding treatments with quinine, arsenic and iron assiduously practised for about four months."

In *Sardinia* we have further confirmatory proof that *the so-called 'human reclamation' is ineffective in combating epidemic malaria.*

In the agricultural colony of Castiadas, Dr. Arturo Mathieu, Medical Officer of Health, followed during the months of the epidemic season, for the whole triennium 1907-09 (inclusive) my method of daily quinine prophylaxis by the administration of two sugarcoated tablets, (in all 40 cgrs.) per individual per day. As may be seen from Table VI, the percentage of fever cases gradually descended from 92 per cent. in 1904 to a minimum of 9 per cent. in 1909. Meanwhile the Superior Council of Health has laid stress upon compaigning methods, as half hearted in respect to quinine prophylaxis as they are energetic in respect to the so-called 'human reclamation'. The Epistolary Herald of this Supreme Body in emphatic language has thus concluded:—

"We direct with increasing alacrity the sanitary forces of the State towards the cure of the sick, the reclamation of the malarial subject; we devote the better part (?) of our medical organization to their assistance; we investigate the most suitable (?!) methods; we multiply anti-malarial dispensaries wherever needful; we erect new anti-malarial sanatoria . . .", and in close conformity

with certain opinions further suggested by ministerial letter, Dr. Mathieu neglected quinine prophylaxis, intensifying curative treatment and prolonging it by repeated hypodermic and intramuscular injections—besides administering quinine by the mouth. With the object of facilitating the ingestion of the drug he employed in particular a formula containing quinine, arsenic, iron, nux vomica, alcohol, and sugar, which appears to have been well accepted.

But after all this energetic human reclamation the malarial sick rate (*vide* Table VI) suddenly reascended in 1910 to 19 per cent., a figure of times prior to quinine prophylaxis.

TABLE VI.

Malaria in the Agricultural Penal Settlement of Castiadas.

Year.	Population living on the 31st December.	Quinine consumed in Kilos.	Cases of Malaria.	Remarks.
1904 ...	748	...	694 (92 %)	No prophylactic quinine distributed.
1905 ...	861	13·674	731 (84 %)	Id.
1906 ...	807	15·080	390 (48 %)	Id.
1907 ...	795	40·230	132 (16 %)	Prophylactic quinine.
1908 ...	700	35·400	97 (13 %)	Id.
1909 ...	601	32·000	64 (9 %)	Id.
1910 ...	655	15·280	139 (19 %)	Suspension of prophylactic quinine.

Thus the too clinico-therapeutic opinions of the Superior Council of Health inflicted a dire experiment upon both guardians and prisoners of the agricultural penal settlement of Castiadas. So to conclude, if we want with the least effort to extract from quinine the maximum benefit by stifling—as above all we ought and can—epidemic malaria, we shall not do so by exhausting the drug beforehand in so-called inter-epidemic treatment. It is enough to begin prophylactic treatment with those actual sufferers from malaria, a little in advance—that is to say during the pre-epidemic spring rise—and quickly thereafter to attack along the whole front, by treating with quinine both those sick from malaria and those presumed exempt, prolonging this action till after the close of the autumn heat, which in some years in littoral areas of the mainland and islands means prolongation till the end of December. I made this proposal before and it was adopted in 1910 even in Algeria; Trambusti also proposes to follow it in Sicily beginning from June (the reaping season) and to continue it till after the cold weather has set in; if necessary to the close of the year.

F.—MEDICAL QUININE PROPHYLAXIS.

Commencing with abroad.—In the French Colonies according to Reynaud "the use of preventive quinine in the prophylaxis of paludism tends to become general and to occupy the first place amongst defensive methods." Mosquito destruction methods were also tried, but on account of their inapplicability to the great waterlogged stretches were abandoned in favour of quinine prophylaxis which is described as "the first, principal, prompt, and general method of defence" because "this defensive method alone can be applied promptly, generally, economically, and in all conditions of colonial life."

And to the question "Is constant or very frequent consumption of quinine devoid of danger? May it not provoke permanent functional or organic mischief?" He not only replies in the negative, but states that those very persons who are the

most convinced adherents of the quinine-hæmoglobinurea theory, recognize that the best means of preventing that occurrence is the methodical and constant use of preventive quinine.

Dr. Mortel also in Hatien (Cochin China) tried quinine prophylaxis amongst the Annamite colonial troops. By way of control he suspended it. After experiment and control he concludes that this prophylaxis, as simple as it is useful, might be made obligatory for aggregations of human beings at all sites to which malaria has extended. So also, according to Gaide's experience with colonial troops, "Preventive quinine therapy applied to the healthy . . . has always yielded excellent results." As for the indigenous agricultural labourers of Cochin China, they believe it to be the only efficacious means of preserving them from fever, better than very costly reclamation works which are often impracticable, and better still than measures of protection against anopheles, badly applied and worse used by an ignorant and apathetic people. The official statement of the Governor of Algeria again is nothing but a pæan of victory for quinine prophylaxis.

Hence De Grall says with reason, that quinine prophylaxis has at length after ten years' trial fully justified the hope I placed in it at the time, in opposition to the outburst of infatuation which then took place for practical corollaries of the anopheline theory.

In the German Navy the value of prophylactic quinine was turned to practical account at all malarial places, and there can no longer be doubt of any kind with regard to its efficiency which is commented on and published broadcast in the official report of 1908-09. In Greece the public health of Anchiolos was restored by the use alone of preventive and curative quinine; a town so badly of in respect to malaria that its population of 2,265 inhabitants was infected in the proportion of 72·80 per cent. at the commencement of prophylaxis, whilst afterwards this ratio fell to 6 39 per cent. in mid summer, and to 2·07 per cent. in autumn 1910.

This simple miracle was accomplished with a consumption of 72·22 grammes of quinine per head.

With good reason does Savas conclude, that in the highly successful anti-malarial campaign in Greece "the most important measure is the preventive and curative use of State quinine." In Bulgaria according to Drs. Bourmoff and Peteroff who came to our school in 1909, the district of Bourgas was chosen as the first test area of quinine administration according to our methods and with our State quinine.

Prior to prophylaxis the megalosplenic index was from 10 per cent. to 90 per cent. in the various villages which may be divided into three categories treated in three correspondingly different ways:—

(1) Those of megalosplenic index 50 per cent. and over daily quinine treatment of malarial suspects and healthy.

(2) Those of megalosplenic "index 15 to 50 per cent. radical" cure of fever cases only.

(3) Those of megalosplenic index 15 per cent. and less no treatment.

After the summer-autumn campaign is over, behold the malarial aspect of these groups entirely changed.

So that—

in group 1 the malarial sick rate had varied between 1 and 40 per cent.,

in group 2 the malarial sick rate had varied between 18 and 52 per cent.,

in group 3 the malarial sick rate had varied between 25 and 49 per cent.

Consequently in the group which at first was most infected malaria had actually descended to the minimum, solely in virtue of daily and universal quinine prophylaxis; and this at the extremely small cost per head of 0·80 lire for the whole five æstivoautumnal months.

Once again was the failure manifested of human reclamation by itself. And *vice versa*, through quinine prophylaxis month by month many and many were for the first time able to pass the fever season free from the suffering and disability entailed by malaria.

The *results obtained in Italy in* 1910 *amongst certain sections of the population* kept under medical observation also speak in favour of quinine prophylaxis. We shall consider to begin with—

A.—The School Population.

Professor Ernesto Cacace of the anti-malarial education stationed at Capua, reports that quinine prophylaxis was continued in the schools in 1910 at Villanova and Terranova-Monferrato, at Pontepossero, at Bova Marina, Salemi, and Serramanna, and was started at Campagnatico, Amorosi, Senisi, Sen Leucio, Massafra, and Marina di Palizzi. The results were uniformly brilliant.

As an instance I shall give details for 1907-08 and subsequent years with regard to:—

Table VII.

Malaria in the Schools of Salemi.

Scholastic year.	Number of scholars.		Relapsing Fevers.	
	Strength.	Number who received quinine.	Total.	Percentage.
1907-08	1,100	200	9	4·5
1908-09	1,252	292	9	3·1
1909-10	1,350	276	7	2·5
1910-11	1,396	131	3	1·3
1911-12	1,500	90	1	1·1

According to Dr. Colucci in the country school of Solito near Taranto quinine prophylaxis was also practised by the administration to the older children of sugarcoated product of State quinine, and to the younger children of tannate chocolates. Out of the total thus protected barely 4·5 suffered from relapse, and that was promptly suppressed by small injections of quinine bichloride.

B.—Military Population.

A glance at Table VIII shows that the success achieved in the protection of the army against malaria from year to year—judged by the diminution both of primary fevers and of relapses—has been increasingly satisfactory; and this result in the unanimous opinion of Principal Medical Officers has been due to the increasingly abundant and more regular diffusion of quinine.

TABLE VIII.

Malaria in the Army.

Year.	Average strength.	Total attacks per 1,000.	Relapses per 1,000.	Primary attacks per 1 000.	Remarks.
1902	199,253	27·44	21·41	6·03	
1903	206,468	24·14	17·85	6·28	Initiation of prophylactic quinine.
1904	210,637	19·21	12·71	6·50	Prophylactic quinine continued.
1905(*a*) ...	218,409	21·52	13·04	8·48	Id.
1906	211,245	18·99	12·67	6·32	Prophylactic quinine extended.
1907	202,320	12·46	7·96	4·50	Id.
1908	216,679	8·04	5·19	2·85	Id.
1909	228,951	6·96	4·72	2·24	Id.
1910	234,104	2·10	3·23	1·87	Id.

Malaria continued particularly to fall in the garrison of Rome though there was no lessening of the periodic recrudescence which took place throughout Lazio.

The good effects of quininization on a large scale were especially observable in the diminished number of those rejected for malaria amongst military conscripts.

For instance Dr. Maltesi notes for Salemi (Sicily) that whilst from 1902-06 the rejected were 23 per cent., they fell to 15 per cent. in 1907, to 10 per cent. in 1908, to 2·82 per cent. in 1909, to 2·52 per cent. in 1910. The following statistics are quoted for the military marine.

TABLE IX.

Malaria in Taranto Hospital.

Year.	New cases.		Remarks.
	Total.	Percentage to strength.	
1900	193	20·19	
1901	130	13·19	
1902	35	14·64	
1903	81	8·33	Commencement of quinine prophylaxis.
1904	89	9·65	Id.
1905 (*a*)	107	10·09	General quinine prophylaxis.
1906	72	7·00	Id.
1907	74	6·75	Id.
1908	46	3·68	Id.
1909	23	1·25	Id.
1910	13	0·75	Id.

(*a*) Year of periodic recrudescence.

For these last results the medical staff of Taranto received the well deserved thanks of the Naval Minister.

C.—Labouring Population employed on Public Works.

Dr. Vincenzo Cioffari gives an account of the results of the anti-malarial campaign of 1910 amongst operatives in the construction workshops of the Pugliese aqueduct. The firm Ercole Antico and company, contractors for this gigantic work, at the instance of the Directing Engineer Vittorio Gianfranceschi, instituted assiduous and regular quinine prophylaxis after my method, daily from the second fortnight in June to the end of November.

The numerical strength of operatives engaged in labour at workshops in malarial situations during the malarial months was as follows :—

June	880	12·83 kilogrammes of quinine were distributed for prophylactic purposes. There were only 7 cases of fever and those amongst subjects of alcoholic excess.
July	865	
August	1,109	
September	1,085	
October	1,261	
November	1,193	

A few years ago the suspension of Public Works (Reclamation works, etc.,) in malarial places was the rule, with sad consequences of grave delay and injury to the works themselves, owing to their interruption precisely in the months of finest weather and greatest daily labour output.

The example of the Pugliese Aqueduct undertaking shows how quinine prophylaxis, apart from its philanthropic aspect, is a paying proposition in Public Works projects.

D.—Mining Population.

Amongst the *Sulphur miners of Sicily* 5,065 received prophylactic quinine during 1910, presumed healthy 3,488, malarial suspects 1,497, fever cases 80. During quininisation but 2 (0·05 per cent.) of the healthy were attacked by fever and of the malarial suspects only 63 (4·2 per cent.) ; and the total sick rate from malaria amongst the mining population under quinine was only 1·3 per cent.

Amongst the *miners of Sardinia*, of those who received prophylactic quinine at Iglesias, 32 out of 4,763 (or ·67 per cent.) were attacked by malaria, whilst throughout the whole mining district 4·90 per cent. of miners were attacked, as compared with 15·50 per cent. in the corresponding agricultural zones.

E.—Agricultural Population.

To the numerous examples quoted in the preceding accounts, of rural centres of labouring industry limited in size and therefore more capable of accurate and precise supervision, which —thanks to quinine prophylaxis—have been saved from epidemic malaria raging around, I would add that of Podere Perogrande in the Catanian plain, where—by constant perseverance in the administration of prophylactic and curative quinine—a locality at first regarded as almost uninhabitable, has become populated.

The *results attained by the use of quinine prophylaxis in various rural districts* beginning with the Roman plain, speak increasingly in favour of quinine prophylaxis.

The following table exhibits the relation between—

TABLE X.

State Quinine and Malaria in the Roman Plain.

	1900.	1901.	1902.	1903.	1904.	1905. (a)	1906.	1907.	1908.	1909.	1910.
Under quinine prophylaxis in the Roman Plain.	...	1,176	3,853	17,506	29,693	38,429	42,726	34,927	33,808	35,800	40,973
Primary infections treated by the Red Cross.	1,716 (17 %)	1,263 (16 %)	764 (17 %)	320 (2 %)	162 (1·34 %)	250 (1·52 %)	139 (0·77 %)	166 (1·44 %)	127 (1·92 %)	201 (0·70 %)	187 (2·2 %)
Chronic cases treated by the Red Cross.	3,751 (51 %)	2,366 (26 %)	2,581 (20 %)	1,547 (11 %)	1,406 (10 %)	839 (5·0 %)	576 (3·4 %)	371 (3·2 %)	437 (2·0 %)	470 (4·2 %)	425 (4·3 %)
Malarial patients admitted to the hospitals of Rome.	6,186	4,275	2,750	2,451	2,961	3,991	2,513	2,486	2,748	2,417	1,775

(a) Year of periodic recrudescence.

Hence within the sphere of action of the doctors of the Red Cross the gradual improvement of public health in the Roman Campagna has been indisputable.

So also in the sphere of action of the Health Officers of Rome there has been a diminution of the malaria-stricken from 1906 on (*vide* Table XI); markedly maintained in 1909-10.

TABLE XI.

Malaria in the Suburbs of Rome and in the Roman Plain.

Sanitary divisions.	Number of attacks from fever in					
	1905.	1906.	1907.	1908.	1909.	1910.
Suburbs	1,138	871	415	525	504	439
Roman Plain	2,917	1,675	925	950	896	1,106
Total ...	3,155	2,546	1,340	1,475	1,403	1,545

In the hospitals of Rome also epidemic recrudescence was much less remarked in 1910 than in 1909.

To encourage the hesitating, Professor Gualdi, Director of the Hygienic Office, insisted that every doctor should personally control, and directly supervise, a quinine prophylaxis demonstration camp.

And the doctors reported unanimously that the result was for the most part favourable; although this practical test in the field was applied for a period about five months in duration, to a fixed population probably already infected. Even those who were at first sceptical extol quinine prophylaxis, and all affirm their plenary confidence in the efficacy of preventive quinine when regularly administered. In the Pontine marshes especially, during the operations of the Red Cross, of apparently healthy individuals and malarial suspects who received quinine prophylaxis, those malaria-stricken numbered—

in 1906, the first year of the malarial campaign, 10·6 per cent.,
in 1907, the second year of the malarial campaign, 6·8 per cent.,
in 1908, the third year of the malarial campaign, 1·3 per cent.,
in 1909, the fourth year of the malarial campaign, 7·2 per cent.,
in 1910, the fifth year of the malarial campaign, 7·6 per cent.

So the recrudescence of 1909-10 therefore maintained a relatively low level, not so much in virtue of inter-epidemic 'human reclamation,' as of that quinine prophylaxis which the Red Cross in Lazio as well as Sicily enjoys the merit of not having neglected even when superior authority attempted to discredit it. So also at Montalto di Castro in the Lazial maritime zone towards the Tuscan marshes, by the efforts of two medical officers of Health, Doctors Ragusa and De Nicola, the periodic recrudescence was kept low in comparison with that of the years 1895 and 1900; assuredly not be it observed in virtue of reclamation (this district being still in its ancient waterlogged state), nor of improved conditions of livelihood amongst the peasantry. For the latter, though their wage was increased, had to confront a rise in price of the necessaries of life, with the result that they still live in a constant state of the lowest intellectual and moral penury, as did their predecessors of fifty years ago.

They declare that the falling off in malaria must beyond doubt be ascribed to the wide diffusion of the specific remedy amidst the whole population. In the quantity (grammes 8·46 per head) in which it was consumed—certainly not enough for the prophylaxis of all and sundry—it was of service in the prophylaxis of not a few and of service chiefly in the prompt treatment of the sick . . . it being nowadays the generally accepted view that the administration of quinine is the sole road to salvation and deliverance from malarial fevers.

Outside Lazio we encounter no instances of districts where it was possible to doubt that the progressive diminution of malaria was more due to the prophylactic work of our colleagues than to spontaneous attenuation.

We shall illustrate this statement by some examples from Lazio downwards.

To the credit of Dr. S. D'Urso the following results have been obtained at Rochetta Sant' Antonio (Avellino) during the past seven years by the prophylactic treatment of malaria with quinine :—

TABLE XII.

Malaria at Rochetta Sant' Antonio.

Year.	Cases of Malaria.	Sick rate. %	Mortality. %	State quinine in grammes.
1904	835	20	2·5	400
1905	627	12	2	679
1906	448	10	0·9	3·125
1907	443	10	0·9	3·923
1908	242	6	0·9	7·000
1909	327	7·5	0·9	3·030
1910	236	5·4	1·1	3·300

In Capitanata also where no one could attribute any merit to hydraulic reclamation works, the precipitous descent of mortality from malaria sequent upon the diffusion of State quinine was evident throughout the whole division.

In some towns especially (Cerignola, San Severo, Torremaggiore) the quantity of quinine administered, in great part for prophylactic use, was the veritable salvation of agriculturists and even more so of harvest labourers.

TABLE XIII.

Malaria in Capitanata.

Year.	In the district of Foggia.		In certain Towns.		
	Deaths from Malaria.	Quinine consumed in Kilos.	Deaths from Malaria.		
			Cerignola.	San Severo.	Torre-maggiore.
1900	1,329	...	52	54	18
1901	1,186	...	76	53	33
1902	666	182·460	24	23	14
1903	632	329·335	29	42	5
1904	797	892·137	17	27	8
1905	609	1,209·755	16	28	5
1906	312	1,157·825	11	18	...
1907	261	1,338·712	3	11	1
1908	172	1,090·877	7	5	2
1909	200	1,094·195	7	10	2
1910	192	1,178·315	6	4	1

For Calabria we quote the following figures on the authority of Dr. Oliva :—

TABLE XIV.

Malaria at Scalea (Cosenza).

Year.	Cases reported.	Cured.	Chronic.	Deaths.	Quinine in Kilos.
1906	2,004	1,302	702	14	2
1907	1,715	981	734	12	2·5
1908	1,443	864	679	9	3
1909	1,610	921	689	13	14
1910	784	602	182	4	22·5

In the district of Reggio-Calabria where the indefatigable work of Dr. Evoli and his collaborators was carried out, 2 per cent. of the quinine-protected contracted malaria, and 18 per cent.—25 per cent. of some residual controls. So, concludes Dr. Timpano, quinine prophylaxis remains the most active weapon we can make use of in the struggle against malaria.

In Sicily amongst 33,387 quinine-protected in 1910, there were no pernicious attacks, and only a few mild cases of fever promptly cut short by curative dosage. As regards details there were with quinine protection—

In agricultural areas 2·6 per cent. of cases of malaria amongst the protected.

In mining areas 1·3 per cent. of cases of malaria amongst the protected.

And according to age, cases of malaria were :—

	0—5.	5—15.	15.
Amongst the presumably healthy ...	3·5%	2·1%	2·8%
Amongst malarial suspects ...	3·2%	2·6%	2·5%

Controls were not wanting: for example, at Marsala, out of 10,300 quinine-protected 157 (1·5 per cent.) got fever, and none died: out of about 15,000 unprotected by quinine 1,292 (8·6 per cent.) got fever, and 34 died; at Castrogiovanni, out of 1,000 quinine-protected 14 (1·4 per cent.) got fever: out of 2,500 unprotected by quinine 350 (14 per cent.) got fever.

Again, due to the zeal of Dr. Alagona—a sanitary official—and of his collaborators, continued decrease took place in—

TABLE XV.

Malaria in the Municipality of Syracuse.

Year.	Number of		Quinine consumed in Kilos.
	Cases.	Deaths.	
1905	...	13	...
1906	500	10	16·6
1907	396	5	36·4
1908	219	1	61·0
1909	320	8	69·0
1910	218	2	49·8

During the last six years, therefore, attenuation of epidemic malaria has here again made rapid and assured progress—principally in virtue of the gratuitous issue of State quinine.

In Sardinia and especially in the district of Cagliari out of 6,963 quinine-protected there were 9 3 per cent. of relapses amongst 4,411 malarial suspects, and 6·69 per cent. of attacks amongst 2,552 of the presumably healthy; and these results were obtained in spite of the fact that enough quinine was not given for entire and regular prophylaxis.

Hence again in 1910 it was undeniable that the quickest and surest means of salvation from malaria is quinine prophylaxis—*bien entendu.*

And as evidence that the truth continues to make successful headway against the obstacles man tries to oppose to it, we are gladdened and rejoiced by the verdict passed upon prophylactic quinine, not by theorists in lofty seclusion, but by medical practitioners working in the arena of daily strife.

One extremity of Italy answers the other. To Dr. Pagnasco who from Concordia Sagittaria (Venice) writes, "Numerous workmen come to me repeatedly to say that they feel stronger and more disposed to work, when they take half tablets of quinine daily", Dr. Maltese replies from the extremity of Sicily, "Amongst the people is now diffused the certainty that the use of prophylactic quinine is absolutely destitute of all harm to the human organism; without quinine they are not secure of freedom from fever: without quinine their fever cannot be cured."

Timpano again in Calabria confirms that "even scoffers see that after quininization fevers of long duration which obstinately persist throughout the fever season, cease to exist", and Sergi in the name also of his colleagues Mazzacuva, Pata, Florio, and Fazzari, lays fresh emphasis on the efficacy, supported by suitable control, of daily quinine administration to the presumably healthy, and the malarially suspect.

Dr. Mazzolani in his turn, supported by a long tropical experience, asserts that the prophylaxis of the healthy exposed to risk of malaria is tantamount to

safeguarding 90 per cent.; and that malarial patients who have already followed discreet quinine prophylaxis have practically cut short by half the duration of the malady.

Another objection however has again been raised against preventive quininization; to the effect namely that it may produce *Chininfasten Malariaparasiten;* in other words, races or strains of parasite extraordinarily rebellious to curative doses of quinine.

The resistance of malarial parasites to quinine in those stages which are designed to secure conservation of species (merozoits, gametes) has been known for some time through repeated clinical and experimental observations. Since 1900, that is to say at a time when quinine prophylaxis was not even spoken of, I have stated my opinion that it is where malaria is grave that relapses of malarial fever too become more obstinate, in spite of every kind of treatment, quinine or mixed.

To-day however some young medical men in our hospitals who have not seen the gravity and persistence of fevers of former times, unhesitatingly blame quinine prophylaxis.

More reasonable is the attitude of Professor Bignami who was the first to import into the field of malarial relapse and its therapeutics, the chemotherapeutical conceptions of Ehrlich with regard to the resistance of trypanosomes to arsenical preparations, and who while conceding that the formation of types truly resistant to quinine may rarely occur, is no less warm in his advocacy of quinine prophylaxis.

Finally Naiva after having described an experience of this prophylaxis in Brazil the cutting short of which by the return of the operatives to a healthy place, exploded their latent infection, arrives at the conclusion that "This says nothing against quinine prophylaxis—up to the present the single and best means of antimalarial defence—but rather suggests the advisability of intensifying it with average daily doses of 40—60 cgr., and of prolonging it even after return to a healthy locality."

For the rest, it is noted that mountain air "brings out the fever;" which means that those who had preserved apparent health in places and months of malaria, frequently fall ill (in hill climates) with obstinate and even pernicious types of fever. No one wonders therefore that in years of graver epidemic, even though regular but insufficient quinine prophylaxis may have been followed for the whole period of residence in a malarious place, if such is not continued for one or two weeks after return to healthy surroundings, fever manifests itself. Such fevers however in general are less rebellious in their relapses to quinine treatment.

This affords some confirmation to the view that, as a rule, parasitic strains, absolutely resistant to quinine, are not formed by the prophylactic use of that remedy.

This much at all events is true, that fevers amongst the protected are more easily cut short by exalting the dose, and raising it from a prophylactic to a curative level.

F.—Mixed Prophylaxis. Quinine and Mechanical protection to Dwellings.

In the past year, 1910, this was continued along the State Railways.

To estimate its value we can compare the records of the ex-Adriatic State Railway from 1888—1901 with those of the same railway under State management from 1902—1910 (inclusive).

TABLE XVI.

Malaria along the ex-Adriatic Railway prior and subsequent to State Control.

	1888-1901.	1902.	1903.	1904.	1905. (a)	1906.	1907.	1908.	1909.	1910.
Percentage of cases ...	69·92	44·93	30·32	33·10	39·44	24·66	22·70	15·79	13·84	13·67
Average duration of each case in days.	7·88	6·99	6·25	7·53	7·64	7·99	8·58	9·67	13·66	14·31
Working days lost per annum per employee.	5·48	3·12	1·89	2·48	3·01	3·39	2·41	3·17	1·89	1·96

(a) Year of periodic recrudescence.

The preceding table with diminishing percentage of cases, and of working days lost through illness, shows progressive improvement along the ex-Adriatic line, when the results of the period 1888—1901 are compared with those of the year 1902 (in which quinine prophylaxis was commenced) and subsequent years.

Better results however should attend the definite organization of an anti-malarial staff along the railway, especially if reinforced by a system of rewards to the diligent and fines for transgressors.

The more eloquent figures of the following table afford us a glimpse of the goal at which we can and ought to arrive.

TABLE XVII.

Malaria along the Sardinian Railways.

	Percentage of employees attacked by malarial fever in the undermentioned years.												
	1897.	1898.	1899.	1900.	1901	1902	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.
Royal Sardinian Railways.	40	46	40	21	17	15	10	15	16	6·4	7·0	8·0	8·6	9·3
Sardinian Company Railways.	...	...	...	...	...	59	58	57	46	3·7	7·6	2·8	2·9	3·8

From this table we see especially in 1910 that in spite of the epidemic widely prevalent in Sardinia, malaria exhibited a mildness amongst railway people in surprising contrast to its severity amongst the neighbouring rural population.

Medical opinion unanimously ascribes this result chiefly to prophylactic quinine.

Amongst customs officials also (*vide* Table XVIII), the malarial sick rate in 1910 was confined to a very low limit (3 per cent. circa).

TABLE XVIII.

Malaria in Customs Officials.

Year.	Number of Customs Officials.	Verified cases of Malarial Fever.	Percentage.	Remarks.
1900-02	1,738	1,035	65·30	No prophylaxis of any sort.
1903	1,751	222	12·73	Mechanical prophylaxis.
1904	1,714	209	12·19	Id.
1905	1,721	187	10·86	Mechanical prophylaxis and commencement of quinine prophylaxis.
1906	1,614	118	7·31	Mechanical and quinine prophylaxis.
1907	1,642	73	4·50	Id.
1908	1,511	73	4·83	Id.
1909	1,876	62	3·30	Id.
1910	1,559	61	3·94	Id.

The statistical details regarding customs officials and railway men of the Sardinian Company Lines thus demonstrate that mechanical quinine prophylaxis reduces and maintains malaria at a level as low as in years and localities of extensive epidemic prevalence can for the present be desired. Finally the following figures demonstrate the benefit which quinine prophylaxis has conferred upon the populations of rural labour centres.

G.—MALARIA AT PONTEPOSSERO AND UNITI (PODERE PONTI).

Year.	Percentage population attacked by malarial fever.
Prior to 1902	60·80%
In 1902	55%
In 1903	40%
In 1904	30%
In 1905	16%
In 1906	9·8%
In 1907	2%
In 1908 (*a*)	2·9%
In 1909 (*a*)	3·2%(*b*)
In 1910 (*a*)	3·4%

(*a*) Years of epidemic recrudescence in the district of Verona.

(*b*) First attacks—about 2%.

The epidemic recrudescence of 1908-10 in the district of Verona was therefore almost averted at this model farm, where the effects of combined water power and drainage reclamation works which leave anophelism entirely untouched were made good by rigorous mechanical protection reinforced by quinine prophylaxis.

H.—DESTRUCTION OF MOSQUITOS.

In Algeria the experiment of inseminating stagnant or sluggish waters with *Azolla*—which by forming a dense and continuous green carpet on the surface impedes the breeding of mosquito larvæ—did not succeed.

At Cervelletta in the Roman Campagna according to the distinguished American Entomologist L. O. Howard, the change during the last eight years has been "simply miraculous," and the salubrity of the place is now perfect; yet anopheles continuously flourish (and could not do otherwise) in the irrigation canals—in spite of the splendid works of local drainage, carried out with a foresight and energy which even to other nations might serve as a model. Warfare against mosquitos of the genus *Culex*, breeding in putrid water within and in the neighbourhood of towns, by destruction of the larvæ assiduously and regularly from May to October, might show more efficacious results.

But even in the German towns which are models of practical organization—especially as regards sanitation—but little headway has been made in the culicidal campaign; whilst according to Muhlens, in the agrarian zones of Germany where malaria has reawakened in latter years, mosquito destruction methods have been laid aside as impracticable, and our plan of gratuitous quinine has been adopted.

I.—Hydraulic Reclamation Works.

Dr. Carlo Galimberti of Chioggia discloses to us the amount of praiseworthy ardour devoted to the establishment of those *companies for hydraulic reclamation and drainage*, which—to the number of 36—intersect the low lying parts of the Rovigo district.

Thousands of hectares of land agriculturally poor or wholly unproductive have been restored to new life; with much greater consequent increase of the value of private property, than of amelioration of paludic and malarial conditions.

He therefore recommends provision throughout the summer months by means of special conduits, of river water to prevent the irrigation supply from putrifying in the drains; and he calls for iron legislative provision to oblige agriculturists who profit by the irrigation, to keep their ditches free from algæ and choking weeds, and to remove every source of stagnation in depressions of the soil; and he expects from the administrative agencies of these companies vigorous and judicious regulations . . . enforced with due stringency: in the case of the negligent, the careless, and the slothful, even compulsorily. But he will cry out and wait in vain! By trusting solely in himself and his colleagues, and scattering quinine with a free hand in malarial prevention—he will succeed much more quickly and easily in quenching the periodic recrudescences of the disease, and will rapidly effect its eradication without inconveniencing legislators, company administrations, and agriculturists, who attend only to the simplest advice, and think of nothing but immediate profit.

To *reclaim the marshes and brackish lagoons* of the continental and insular littoral, Casu proposes to turn them into breeding preserves for fish, by facilitating more rapid and more ample communication with the sea.

According to Di Pace marginal reclamation of these collections by deepening and banking them up so as to bring about the disappearance from their edges of palustral flora, with such increased surface disturbance by the motion of the waves that they will no longer lend themselves to mosquito breeding, turns out continuously more costly and frequently does not fulfil in practice the conditions necessary to mosquito destruction; particularly is this the case in water channels which empty themselves into inland water basins, and in natural or artificial bays of the latter.

The transformation of these collections into sea water in addition to being more remunerative would be efficacious in destroying anopheles larvæ.

We should thus have *industrial hydraulic reclamation* which—no less than agrarian hydraulic reclamation—I have for some time advocated with the object of extracting the maximum benefit—directly economic and indirectly hygienic—from these huge and costly public works.

The drying up of marshy areas by utilising the transpiratory properties of trees appears to be more and more of a failure.

Taxodium Disticum planted in Algeria for this purpose proved even less useful than the Eucalyptus and Willow.

J.—Agrarian Reclamation—Colonization.

To those who extol agrarian reclamation and colonization as the panacea for malaria, I dedicate the new facts disclosed by observation during 1910. Proceeding from North to South I observe that in the fraction of Santa Maria in Punta which is covered by the operations of the Isola d'Ariano Hydraulic Company, recrudescence of malaria took place subsequent to reclamation—to be precise in 1908-09—on a scale unparalleled in pre-reclamation annals.

The same is true of Loreo Municipality, where during the last triennium (1908-10) periodic malarial recrudescence followed its fatal course, though the area hydraulically reclaimed was under dry intensive cultivation as perfect as that of the best cultivated districts.

Such is the account of Dr. Galimberti of Chioggia, and Professor G. Brambilla, Director of the Peripatetic Anti-malarial School, confirms it.

Doctor Mayer in his turn assures us that the failure, notwithstanding official enquiry, to explain the unforeseen increase in malaria for the four last years in succession in the district of Adria, where improved reclamation of agrarian hydraulic type had been completed, created considerable stir. In the end beet-root was blamed and some even went to the length of preaching the necessity of prohibiting its culture!

Clear and obvious therefore was the return of one of those periodic recrudescences of malaria, which in past times brought such ruin upon the most flourishing colonizations, and which—though now-a-days milder and more transitory—can, and should, none the less be curbed by the administration of prophylactic and curative quinine.

Near Grosseto also, at the splendid Ricasoli farms, Professor Memmi has been able to prove tangibly that intensive cultivation by itself has had no influence in diminishing malaria, and still less in causing (as some believe) malaria to disappear.

In Sicily—according to Janni—near Riesi, despite intensive culture of the surrounding hills, malaria has not been removed, and thanks to quinine alone has it been possible so far to subdue it.

The same may be said also of other towns and rural boroughs in the island.

But even more typical was, and is, the example of the Rizzolo property within Francofonte Municipal limits. Here, according to Trambusti, vines, lemon trees, almond trees, mulberry trees, olive trees, and cereals were planted for the last three years by intensive culture; hygienic dwellings provided in addition with wire gauze netting which (through the negligence of the colonists proved inefficacious) were constructed; mosquito curtains were introduced, and the irrigation reservoirs petrolized.

But notwithstanding all this splendid reclamation work, and despite the persevering efforts of the proprietors, malarial infection remained constant and severe, until in 1910 the simple and easy administration of regular quinine to the healthy and the malarial, opened a new era of salubrity.

K.—Special Legislation against Malaria.

According to Reynaud "the Italian Government has put into force a collection of laws which are models for imitation;" and they are in fact becoming continuously more extended amongst the colonizing nations of tropical countries.

A decree of the 20th of October 1905 authorized the Governor-General of Madagascar to take measures to facilitate the sale and distribution of quinine to the population of the colony. Other ministerial decrees of the 16th of March 1909 and 25th of April 1910 gave similar facilities to the Governor-Generals of Cochin China, and Western and Equatorial Africa, and to the Governors of Guiana, Martinique, Guadeloupe, Rèunion, and the French possessions in India.

By these decrees the struggle against malaria is organized and generalized for the first time, and quinine prophylaxis compared with all other prophylactic measures is placed in the forefront. The Argentine Government also by law No. 5195 of 1907, and by regulation of the 30th of July 1911 has adopted our legislative programme.

All the more then are we constrained by the spirit of "*noblesse oblige*" to perfect it in conformity with the teachings of experience in latter years. At Mantua, for example, it has been demonstrated again and again that *provincialization*—in part of the province—of the purchase and sale of quinine, working through the provincial doctor down to communal health officers, is one of the most righteous and efficacious of social ordinances for the defence of the working man against malaria, and for the '*Mise En Valeur*' of the soil.

There is also need of utilising to better advantage the treasury balances of the Home Department and of the Quinine State Factory (*vide* Table III) with the object of supplementing the work of municipal administrations where the latter is deficient, and especially of eliminating the continued transport of contagion by itinerant nomads of the agricultural labouring community in the more severely stricken cultivation stretches.

The quinine prophylaxis experiment conducted amongst the gleaners of Barletta with funds furnished by the praiseworthy Visconti di Modrone Institut, and through the zealous labour of Dr. Casardi and his two colleagues—whether on account of the successful protection of its recipients, or the strident contrast presented by the unfortunate human flotsam and jetsam of malarial fever—shows how very necessary is that organization, which apart from and in addition to the poor and insufficient action of municipalities, I have for years been calling for throughout the Tuscan marshes, Tavoliere delle Puglie, the Metaponto plain, and every other cultivation stretch on the Tyrenean, Ionian and insular littoral.

L.—Organization of the Anti-Malarial Campaign.

This must be adapted to local conditions. And where (Tuscan marshes, Lazio, etc.) new colonization is started far from an inhabited area, there is need of stationing dispensary doctors and establishing *rural dispensaries* in the heart of the fields. The Municipality of Rome was the first to set a good example in this matter as far back as 1874. The rural dispensaries in the heart of the Roman Campagna to-day number 16 with 9 more in the suburbs. And further steps are now being taken to increase and improve both.

Where long established intensive culture (vines, gardens, etc.) is growing close to the large rural boroughs (southern continent and islands) and the peasants go to the fields in the morning and return in the evening, *itinerant anti-malarial stations* are of use on roads of communication, for the purpose not only of repressing but also of preventing malarial fevers by the administration of quinine.

Lastly, where (Tyrenean and Ionian marshes, Sicily, Sardinia) cultivation stretches and extensive culture predominate, travelling doctors and nursing attendants, equestrian or vehicular—as organized to admiration by the Red Cross in the Roman Plain, Pontine marshes and Sicily—are indispensable.

The *Malarial file* devised and used since 1904 by Dr. Tuveri at Villaputzu (Cagliari) is worthy of praise and imitation by dispensary doctors.

Such a file is composed of personal sheets containing the so-called malarial life history; easily displaced to admit of their preservation in rigorous alphabetical

order, and to allow at need of their arrangement for purposes of statistical elaboration—in order of date, age, sex, civil status, economic condition, etc.

To each of these sheets is applied a loose cover made of pasteboard folded in two, with one side the same size as the sheet, and the other windowed in such a way as to admit of the title and principal entries of the contained sheet being seen without taking it out.

Two colours are adopted for the sheets (male and female) and four for the covers (white, red, green and yellow) corresponding to cure, first attack, relapse, chronic condition. There is thus the advantage of being able by a single glance at the series to see the state of the malarial problem in a community; that is to say of being able to determine day by day the total number of sick, the separate number of first attacks, relapses, and chronic cases, and the number of cures at each age period and in both sexes.

So extensively however and so constantly in many a malarial district is the work of the dispensary doctor and health officer still opposed by the ignorance of peasants, the apathy of landlords and farmers, and the confusion of Municipal Administrations, that it is difficult to establish efficacious prophylaxis against the malarial scourge.

Hence it was that in deference to certain of our distinguished pathologists and clinicians, prophylaxis was neglected during 1910 even where (district of Grosseto) it had proved tangibly beneficial.

A sense of sadness invades the mind that reflects upon this retrograde step through which it was attempted to retard Italy's progress by fettering the prophylactic movement so laboriously initiated.

The principle of *maximum utility with minimum means* was forgotten, and either by new attempts at organization entrusted to unskilled hands, or by the so-called "human reclamation," the intra epidemic campaign was spoiled; and worst of all much energy and vast sums of money, which might most usefully have been concentrated during the summer and autumn upon places where the conflict was at its worst, were expended on sanatoria. The eloquent example set by the Sicilian Red Cross, who succeeded in extracting maximum utility with the smallest effort from prophylaxis—as opposed to mere treatment and sanatoria ought now to be preached.

In Sicily to wit:—

On sanatorium treatment—resulting in 86 recoveries after 2,011 days in hospital—6,940 lire were spent in the æstivo-autumnal season at a total cost of 80 lire, and a daily cost of 3·45 lire per head.

For this latter sum about 42 persons might have been protected throughout the whole æstivo-autumnal season by prophylaxis.

In the inter-epidemic campaign 3,358 individuals were treated at a more or less frugal expense of 36,125 lire, that is to say 10·75 lire per head, an amount which would have sufficed to protect between five and six persons.

On the other hand during the epidemic period, 24,564 persons were protected by prophylaxis at a cost of 46,305 lire, or 1·88 lire per head.

For educational purposes *prophylactic demonstration camps* are also particularly necessary. These, interdicted at home by a mistake, were welcomed with the happiest results in Algeria.

The *propaganda of local medical men* ought to be better promoted and more liberally rewarded. The school with its demonstration propaganda—that is to say the quininization of scholars, and the hunt for mosquitos, as well as assiduous oral instruction and illustration—ought increasingly to imbue the rising generation with the principles, and instil into it the habits, which result from that anti-malarial and sanitary education upon which—as upon the keystone of an arch—modern prophylaxis rests.

The *anti-malarial education station* of Naples and Capua, directed towards this noble ideal by Professor Ernesto Cacace, has continued its mission in normal and popular schools from Alexandria to Salemi.

The *Viscenti di Modrone Institute* with its travelling lectureship against malaria has contributed in Venice (Chioggia and Donada) and in the South (Fiumeri, Rochetta, Sant Antonio, Barletta Metaponto, Rotondella, Sorano, Taranto, Crucoli) to the diffusion of hygienic and prophylactic rules for avoidance of the disease, and to the gratuitous distribution of quinine (sugar-coated preparations and chocolates) to the poor; especially to itinerant labourers, for whom the laws make no provision. In these ways it has assisted the progress of agriculture and colonization in malarial tracts.

We cannot impress too much upon the rich and lazy owners of cultivation stretches, the example of that philanthropic gentleman of Milan whose financial donations were, with the active co-operation of Professor Giuseppe Brambilla, as effectively utilised, as they were generously bestowed.

The attention devoted to cholera disturbed the anti-malarial campaign in places.

M.—Prophylactic Conclusions.

1. From Italy the social provision of quinine by the State has gradually spread to Austria, Greece, Bulgaria, the Argentine, the French and Dutch colonies, and also (perfecting a long standing institution) to English India.

2. In Italy from 1902 to 1908 while the consumption of State quinine progressively increased, mortality from malaria correspondingly diminished by two-thirds. From 1908 to 1911 the consumption of State quinine remained stationary with slight oscillation, and mortality from malaria remained correspondingly constant at a figure of about 3,500 deaths per annum.

3. Mortality from malaria from 1902 to 1911 underwent most diminution in the divisions most infected and most disorganized (Basilicata, Sardinia); and those periodic recrudescences moreover—which appear to have been as severe as they have always shown themselves in other epidemics—ceased throughout the most malarial parts of Italy from Lazio downwards.

4. On the whole we are justified in believing and hoping that vigorous and united effort by facilitating the use, and increasing the consumption, of the valuable State drug, will result in the continued decline of malarial mortality.

5. Since we have as yet no prompt and certain means of diagnosing latent infection those parasitic forms which subserve the conservation of species in man and mosquito (manage to survive and) are still as in various years and localities, they have been in the past absolutely resistant to quinine and every other remedy.

No remedy therefore, quinine not excepted, is always effective in enabling us to eradicate malarial infection at will; and so not even with the most accurate inter-epidemic and pre-epidemic treatment—much less with the kind of sanatorium that gathers in little carriers of plasmodia without the means of curing them all permanently and effectively—can we believe it possible for malaria to be exterminated (*hoc opus, hic labor est*) in an extensive locality already overrun by the disease.

6. In places of severe or even moderate epidemic prevalence malaria may not only be cured, but even better prevented with quinine. Hence quinine prophylaxis, resisted in Italy by some clinicians and pathologists, has spread itself all the more rapidly to every corner of the malarial world.

The *Consensus Omnium* to-day places it in the first rank amongst anti-malarial measures, not alone for civilized countries but even for the colonies.

7. Prophylactic quinine followed by us in 1910 has given moreover, where it was most regularly used, the most brilliant results; for example in schools, in the army, in the marine in the forges of the Public Works, amongst miners, at rural labour centres, and amongst agricultural populations. Where unfortunately it was suspended controls were not lacking to demonstrate all the more clearly its efficiency; whilst in confirmation of its harmlessness none of those inconveniences and drawbacks—postulated but not proved by hostile theorists—were verified.

8. In our more intensively cultivated levels, no less than in those under broad cultivation, the anti-anophelic campaign (except by the protection of the houses of a few of the better off against mosquitos) is not practically feasible.

"Mixed prophylaxis (anti-plasmodic and anti-anophelic)" on the other hand, where—as in the case of our customs guards—it can be simultaneously carried out by the administration of quinine and the provision of wire gauze netting to keep mosquitos at a distance from dwellings, conduces to reduce malaria to a minimum, and to render it as mild as can possibly be wished.

In this sense it should be brought to a higher pitch of perfection along our railways, especially those of the State.

9. The urgent necessity of reforming the more costly and less remunerative of our laws with regard to hydraulic reclamation, is now universally recognized with the view of subordinating these projects and their execution to economic requirements—agricultural or industrial; of leaving to the medical hygienist the prevention and cure—*hinc et nunc*—of malarial fevers; and in concert with the engineer and the agriculturist, of preparing the *entourage* in such a way, that the '*mise en valeur*' of the locality, may contribute to the fixity and maintenance of human tenure during all months of the year.

10. Improvement in our legislation with regard to State quinine is increasingly urgent, with the object of placing on sale not only abroad but more especially at home, further indispensable compounds (tannate in chocolates), as well as of facilitating the provision and distribution of the various quinine products through the medium of divisional administrations in preference to municipalities.

11. Sanitary anti-malarial organization likewise requires urgent perfecting at its distal points; with the object of securing Government supervision of wandering malarial carriers of the peasant class; of establishing *rural dispensaries* as the first nuclei of new colonisations; of perfecting in a prophylactic as well as curative sense *itinerant anti-malarial stations* for the populations of large rural boroughs; of sending *doctors and travelling nursing attendants* to preserve and cure from malarial fevers people scattered through the cultivation stretches. Better pay should be given to sanitary inspectors and distributors of quinine under medical supervision, and sanitary and anti-malarial educative propagandism amongst the people should be supplemented by medical and school lectures—possibly even by lantern demonstrations.

12. To Italy, the first to take the anti-malarial field, belongs the duty of leading the van in this war against the malarial scourge, which by energetic and concerted effort can now be so easily vanquished. The conquest of fresh colonial territories, where malaria is also one of the enemies to be overcome, ought not to make Italy forgetful of her duty towards so many districts at home,—now as well as in the past, rendered miserable and desolate by malarial fever.

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MALARIAL OPERATIONS IN THE CITY OF BOMBAY

By Dr. J. A. Turner, M.D., D.P.H., Executive Health Officer, Bombay Municipality.

Bombay is situated on an island on the shore of the Arabian Sea in 18° 55′ N. and 72° 54′ E. This Island was composed formerly of 7 small islands, and forms one of a group lying off the coast of the Northern Konkan. It is now permanently united with the larger Island of Salsette, and with the mainland by means of causeways, bridges and break-waters.

The climate of Bombay is warm, equable and humid. The average mean annual temperature is 79·6° Fah., January being the coldest month with an average mean temperature of 73·9° Fah., and May the warmest with an average mean temperature of 84·7°.

The total population of the City during the last Census was 979,445. This figure represents only the fixed and permanent population; there is besides a floating population of about one lakh and consists of people of the labouring class who visit Bombay during the dry weather, returning to their own homes just before the onset of the rainy season. Practically the total population during the greater part of the year varies from 900,000 to a million.

The total annual average rainfall is 72 inches; during the present year it was 52.

The atmosphere of the City is generally moist, the lowest relative humidity of 0·668 (1,000 denoting complete saturation) occurs late in December.

The prevailing winds vary according to season. During the monsoon months the wind blows from W.-S.-W. The maximum velocity is 18·8 miles per hour and is attained in July. By November the prevailing winds come from the N.-E. but from January onwards, the easterly component gradually disappears and is replaced in March by a westerly one.

The total area of Bombay is 22·55 square miles.

During the year 1911, the total death-rate of the City was 35·69, the birth-rate 21·82, and the infantile mortality was 379·8.

The Municipal Administration :—At the head of the Municipal Administration of the City are the Municipal Corporation, the Standing Committee, and the Municipal Commissioner, who is a member of the Indian Civil Service.

The entire executive power is vested in the Municipal Commissioner. To assist him in the discharge of his duties, there are four heads of Departments, including an Executive Health Officer and an Executive Engineer.

The revenue of the Municipal Corporation in 1911-1912 was Rs. 1,20,77,000.

Sanitation :—The Public Health Department of the City is under the control of the Executive Health Officer assisted by two Assistants. For administration purposes the City is divided into seven Wards, each of which is in charge of a Deputy Health Officer, who is a qualified medical man.

The Deputy Health Officers are responsible both for Conservancy and Sanitary work in their respective Wards. They are each assisted by a staff of Sanitary and Conservancy Inspectors, Assistant Inspectors and Sub-Inspectors.

For the purposes of registration of births and deaths and for free medical relief, the City is divided into 10 Districts. In each District there is a Registrar, two or more Sub-Registrars, and one trained nurse or qualified midwife. The Registrars and Sub-Registrars are trained medical men. The former have

charge of the Municipal Dispensaries, in addition to their own duties, which include the registration of births and deaths, the checking of Cemetery returns, enquiring into the causes of deaths, and disinfection of houses and rooms in which infectious disease has occurred.

The staff of Inspectors and Subordinates engaged in the sanitary and conservancy work of the City during the year 1911-1912 was as follows :—

3 Chief Inspectors.

8 Sanitary Inspectors.

9 Conservancy Inspectors.

70 Assistant Sanitary and other Inspectors.

During the year 1911-1912, Rs. 21,43,165-15-0 were spent on the Public Health Department, Rs. 4,72,857-9-1 on Hospital and Medical relief, and Rs. 1,55,903 on Plague work, and Rs. 84,000 has been estimated for Malaria.

Before proceeding with the subject of the present measures adopted by the Corporation for the extermination of Malaria in Bombay, I will say a few words about Malaria in Bombay in previous years, with a view of showing what has been done in the City with regard to Malaria since 1901, the period that has elapsed since the Mosquito-Malaria theory was accepted in 1900. I do not say that a great deal more could not have been done in the light of later knowledge. But I offer no excuse for not undertaking such work on the scale which mosquito enthusiasts demand without taking into consideration certain practical issues. The reasons that special campaigns were not undertaken were that other and more important duties claimed our attention. The incidence of Malaria in Bombay was not sufficient to warrant enormous increase in expenditure. The finances of the City were being strained to the utmost in measures to control Plague, Cholera and Small-pox and improved sanitation generally. These notes are no sort of apology for the Health Department nor for the Corporation of Bombay. They are the facts as they occurred, and if the time has arrived when the pressure of work in Plague, etc., is less and more attention can be given to the prevention of Malaria in Bombay, the Corporation and its executive will be willing and able to carry out such work, bearing in mind the practical difficulties to be overcome and with a due sense of the enormous work to be done in a City like Bombay.

In September 1901, a Committee of 11 Members of the Corporation of Bombay was appointed to consider the measures necessary for the prevention of Malaria in the City. Thus Bombay was the first City in the World to make any attempts to combat Malaria on the then most recent knowledge.

On the 19th December 1901, the Executive Health Officer submitted the following Report to the Commissioner :—

"With reference to your Nos. 16884 and 18925 of the 21st September and 11th October 1901, respectively, I have the honour to forward the subjoined report on the presence of Anopheles larvæ. In this connection, I would mention that the Divisional Health Officers have for some time past been devoting their attention to the presence of larvæ in various parts of the City and are able to supplement the places where larvæ have been found by many other places.

"It will be seen from the Divisional Health Officers' reports, which I append, that their investigations practically extend all over the City.

"The chief specimens of Anopheles mosquitoes found in Bombay are :—

"Anopheles Rossii, Barbarosi, Jamesii, Culicifacias, Stephensi, Listonii.

"Of these the Anopheles Culicifacias and Listonii are the only Malarial-bearing mosquitoes known here at present.

"The Anopheles larvæ are found where water collects for any time. In large collections of water or large open tanks, the presence of larvæ has been detected—but only in small numbers and these chiefly in the dry weather when

more shallow pools are dried up; in a few wells inside houses, and in puddles on the road side, and wherever small quantities of water collect in road side ditches where there is very little fall, the presence of a small quantity of sewage or polluted water does not appear to be inimical to the larvæ and they have been found on the fore-shore of Nepean Sea Road in water which is actually salt. That the Anopheles larvæ are ubiquitous must be accepted and that a small puddle of water in the compound of a house is more dangerous than a tank or swamp half a mile away.

"I advise the Committee therefore that the best known means of preventing the breeding of Anopheles is to drain all marshy and low-lying land, by providing surface drainage with a sufficient fall in all places where water collects and remains for any time; that when the land cannot be so drained and filled in, the only means for destroying the larvæ is by introducing some larvicide as kerosine, tar, or any of the substances known in the market—as Anophelecidum—a hydrocarbon compound which is now being used.

"The Divisional Health Officers have anticipated the report of the Committee and have for some time been taking steps to destroy larvæ in their respective districts and have instructed their Inspectors in the methods to be observed and the reasons for doing so.

"The Committee can, however, strengthen the hands of the Health Department by recommending to the Corporation the necessity for keeping all existing tanks well supplied with fish and by draining and filling all lands where water collects and making all roadside drains of sufficient fall with smooth impervious sides.

"The fact that a species of Anopheles mosquito is the vehicle which conveys Malaria is now widely known, but any attempt made to permanently destroy the larvæ will be futile, until the public generally recognise that the Anopheles mosquito cannot breed without water, and they are educated to appreciate the fact that Malarial fevers are the cause of most of the sickness in the City, that mosquitoes hate light and air and love darkness and damp. The aim then should be to get rid of the possible breeding places and to take such steps as are necessary to prevent the collection of water near houses.

"Summary of Divisional Health Officers' reports on breeding places of Anopheles larvæ:—

(1) Various public fountains.

(2) Marshy ground at Pilot Bunder, Chowpaty and Wari Bunder.

(3) Various public tanks and wells.

(4) The countless pools found throughout the Island.

(5) Certain storm water drains.

(6) Certain quarry holes.

(7) Pools in rice-fields at Matunga.

(8) Trenches by the sides of the Railway embankments."

On the 6th March 1902, the Corporation at their ordinary monthly meeting resolved:—

> "That the report, dated 4th February 1902, of the majority of the Committee appointed by the Corporation Resolution No. 7232, dated 9th September 1901, to suggest measures for keeping the tanks, etc., of the City free from Anopheles larvæ be approved and adopted, and a copy be forwarded to the Commissioner with the request that he will take action as suggested by the Committee."

The Report of the Committee stated that Anopheles larvæ had been found in every part of the City and in a great variety of situations and only to a limited extent in tanks and wells, but abundantly in fountains, in pools formed by

leakage from reservoirs, standpipes and water taps, etc., that, as the six species of Anopheles mentioned were all very much alike in outward appearance, it was not practicable to discriminate between them in carrying out measures for their destruction, and that though the distinction between the two main varieties of mosquitoes, *viz.*, Anopheles and Culices was marked—yet the Committee thought that it would be better if the officers of the Corporation did not restrict their efforts to Anopheles, but rather aimed at the destruction of all mosquito larvæ as, although Culices had not been shewn to convey Malaria, yet they might convey other diseases and, moreover, the annoyance and the irritation caused by them might not be without effect on the health of the people. The Committee further stated that they recognised the importance of securing the co-operation of the public if any success was to attend the operations of the Municipality.

For practical purposes the Committee divided the breeding places into two classes, *viz.*, (*a*) those which are permanent and (*b*) those which are formed by rain during the monsoon season only.

With respect to class (*a*), they recommended that vigorous action be taken at once; that all wells, fountains, and tanks, which it was desirable to retain should be cleaned up, if necessary, and stocked with fish; others should be drained or filled up. In some cases (*e.g.*, wells within houses, cisterns and storage tanks), the water should be protected by wire gauze or perforated metal sheets; that collections of water round standpipes, hydrants, or storage tanks and also those formed by leakage from the reservoirs should be dealt with by surface drainage. These and also gully-traps found to contain larvæ might be treated with kerosine oil or tarred once a week.

Places where Anopheles larvæ were found in private premises should be dealt with under Section 381 of the Municipal Act.

To deal with class (*b*), the Committee thought that the whole of the subordinate staff of the Health Department and, if possible, the Drainage and Road Departments also, should be taught to distinguish mosquito larvæ and to watch for pools, etc., containing larvæ and treat such, when found, with kerosine or tar, and that, when they found such measures impracticable, they were to report to their superiors, and that the Executive Engineer should be requested to co-operate with the Executive Health Officer.

During the past 11 years, every section of the City has been, to some extent, dealt with. Had this not been so, what would have been the position of Malaria in Bombay to-day can only be conjectured.

From the first, the measures taken by the Health Department with regard to Malaria were part of the routine work of the Health Department, always in the direction of improved sanitation, draining, levelling and filling in, cleaning of wells and tanks and sanitary measures as well as mosquito extermination. No so-called campaign *per se* against Malaria had been undertaken for this reason.

In 1901, the whole of the Plague measures were taken over by the Health Department. It was considered that Plague, Cholera and Small-pox should receive more attention than Malaria.

In 1905 the Corporation asked the Government of Bombay to appoint a Committee to enquire into the prevalence and causation of Malarial and other fevers in Bombay. The Committee was comprised of representatives of the Government Medical Service, Sanitary Service and Mosquito experts, members of the Corporation and medical men, and took a large amount of evidence from medical and lay residents in Bombay and was provided with two special officers of the municipal Staff—medical and engineering—and all the reports of the Health Department for the past 20 years. The Committee sat from 1906 to 1908 and issued a report from which the following is an extract:—

"We may premise the consideration of this part of our report by attempting to arrive at some understanding of the expression 'Malaria and other fevers.' The term 'Fever' is popularly used in India to denote a condition of ill-being which is known by the modern medical practitioners to be produced in a number

of diseases. At one time, however, the term 'fever' was held, in India at least, to be practically synonymous with the term 'malaria.' But as medical knowledge has year by year progressed, various types of fever have been differentiated, so that now among the more advanced physicians, fever is regarded as a symptom of a disease rather than as a disease in itself. It thus comes about that the expression 'Malaria and other fevers' has a different significance for different persons, according as each is more or less *au fait* with the recent advances in the scientific study of disease.

"Unfortunately, however, even those medical men, who are more anxious to be accurate in the names they apply to diseases, are forced at times, on account of a defective nomenclature for tropical diseases, to erroneously classify, for the purposes of registration, a fever as Malarial, which may not in any way be connected with the presence of the Malaria parasite in the blood.

"The year 1900 marked the turning point in the health of the City, for from that year till 1907 the death-rate has fallen with slight fluctuations to 39·56 in 1907.

"If we compare the mean annual death-rate for the ten-year period before the advent of Plague in 1896, *viz.*, the period 1886 to 1895, which had a mean annual death-rate of approximately 29, with the ten-year period after the advent of the Plague, 1896 to 1905, which had a mean annual death-rate of nearly 65, we observe that the death-rate had more than doubled. It should, however, be remembered within the latter period are embraced four years of scarcity and famine which were attended by an enormous mortality from Small-pox, Cholera, Dysentery and Diarrhœa. Bearing this in mind and allowing a wide margin on this account, we are struck by the sudden and remarkable increase in the death-rate of the City coincidently with the advent of the Plague. We are thus forced to the conclusion that the increased unhealthiness of the City must, in large part, be accounted for by the presence of this disease.

"In seeking for confirmatory evidence for this conclusion, we may refer to the recorded deaths from Plague and observe that out of 517,952 deaths from all causes, during the years 1896 to 1905, no less than 141,285 deaths have been recorded as deaths due to the Plague. That is to say, that more than three-tenths of the total deaths during this period were attributed to this disease. It is well known, however, to those who have had the opportunity of studying Plague in the City that only a portion of the total deaths actually due to this disease are recorded as Plague deaths. Many which are really due to Plague are registered under such terms as Phthisis, Fever, Asthma and the like, in order that the friends of the deceased may avoid the inconveniences associated with anti-plague measures. We will not be making an over-estimate, we believe, if we state that during the first 10 years of Plague, four-tenths of the total deaths within the City were due to Plague. Fortunately during the past two years, *viz.*, 1906 and 1907, there has been a marked diminution in the number of deaths from Plague and the death-rate for these two years shows a steady improvement.

"*In our opinion the importance and the magnitude of this element (the plague) in the unhealthiness of the City, places all other diseases in the background and demands even greater attention than has of recent years been given to it.*"

Thus the incidence of Malarial fever up to 1908 in Bombay appears not to have been of sufficient importance, to justify the Committee in recommending any extraordinary Malarial measures.

In the months of July to October 1908, however, about the time the report of this Committee was published, a wave of Malaria spread over India, including Bombay, and the following is a short history of the epidemic in the City.

During the year 1908, the month of October witnessed the highest mortality from fevers and registered 407 deaths; in June the lowest figure was recorded, *viz.*, 217. January to June were months of diminishing prevalence; and July to October of increasing prevalence; thereafter a decline was again visible.

The following is the mortality from fevers during the period from 1895-1911 :—

Years.	No. of deaths from fevers.
1895	6,404
1896	8,776
1897	6,951
1898	4,114
1899	5,063
1900	7,928
1901	7,921
1902	4,518
1903	2,333
1904	2,416
1905	2,878
1906	4,882
1907	3,663
1908	3,403
1909	2,800
1910	3,113
1911	3,146

The figures indicate a decreasing mortality from 1907 to 1909; in 1908 there was a reduction in the number of deaths by 230 below that of 1907.

During the third quarter of 1908, a wave of Malaria severer than usual, swept over India, and Bombay suffered in common with the rest. A and B Wards suffered most, and in the former, especially Fort North. Reports on the prevalence of Malaria and anti-malarial measures taken and suggested, with an enumeration of the various breeding places in the City of the Malaria-bearing mosquitoes were, from time to time, submitted to the Commissioner and the Corporation. They were to the following effect :—

The importance of the disease in relation to its influence on the public health cannot be over-estimated; it is not the death-rate that is appalling, the majority of cases are not immediately fatal, but the more or less permanent injury to the constitution resulting from neglect.

In 1909, a report on the history of Malaria in Bombay from 1901 to 1909 was published giving details of work done.

A careful examination of different localities in the City revealed several breeding places of mosquitoes :—

I. The New Dock Works :—Very frequent and extensive inspections of the works were made in company of the Port Trust Engineer and the Agent of the Dock Contractors : the measures comprised the cutting of all rank vegetation, the filling in of all pools, where necessary and possible, and frequent treatment of

others with pesterine by this Department; the issue of prophylactic doses of quinine to the workmen. The authorities co-operated with the Health Department and did everything that could be reasonably expected of them.

II. The deep excavation at the western extremity of the New General Post Office Buildings; letters were addressed to the Consulting Architect to Government, who ordered the pool to be treated with kerosine twice weekly.

III. The compound of St. George's Hospital owing to the presence of rank vegetation and accumulation of barrels, empty tins and iron basins. The Physician-in-charge was addressed with a view to the removal of these.

IV. The yards of the Bombay, Baroda and Central India and Great Indian Peninsula Railways to the west and to the north-west of the Hospital; in the former, there were two large old quarries full of stagnant water and the surroundings were overgrown with rank vegetation; in one of these, stable refuse was being deposited: this particular area being highly insanitary and a source of danger. In the latter yard two or three shallow pools of rain water were found to contain larvæ of Anopheles mosquitoes. These were immediately treated with pesterine by the Health Department and the Railway Authorities were requested to fill them up and remove the rank grass.

These places contributed largely to the plague of mosquitoes in A Ward; there were other large compounds in this and in every other ward, where old iron empty tins and barrels, disused chatties, garden tubs and other receptacles were allowed to accumulate rain water and thus afford a breeding place for mosquitoes during the rainy season, more especially towards its close.

V. The extensive building operations in progress in different parts of the City; these involved soil disturbances and afforded ideal sites for water to collect. Anopheles larvæ in large quantities existed in such pools and also in tubs used for steeping brick.

VI. Innumerable private wells to be found inside the houses; these constitute a grave potential danger and much of the Malaria in Fort North was probably due to this.

The remedy lies in filling up or permanently covering the wells proved to contain larvæ and the provision of a small hand-pump for raising water when required: the cost would be negligible and the improvement in the health of the residents of the neighbourhood considerable.

VII. The large number of tanks and the public wells in the different parts of the City (2,294 in all), many of which, on examination, were found to contain mosquito larvæ in large numbers.

VIII. Cisterns and storage tanks: these should be kept covered and where this was not the case, the owners were written to and requested to remedy the defects and meanwhile any larvæ found were destroyed.

IX. In various parts of the City, particularly in its outskirts, large areas of low-lying ground exist which in the monsoon become flooded and overgrown with rank vegetation, thus forming an ideal breeding ground. In process of time these will be rendered more healthy by the extension of the City; meanwhile, these should be drained; failing drainage these areas should be filled, though the process would be very expensive to a private owner.

X. Many of the unlicensed stables in the City constitute a source of danger, as they are not paved and drained, and the surroundings become a swamp in the monsoon and even in other seasons. The amendment of existing bye-laws and proposals for abolishing such places entirely are under consideration.

XI. The drains of the City, especially the storm-water drains, particularly about the close of the monsoon when short breaks occur. During the dry season also, house and stable sullage finding entry into them, breeds mosquitoes in various parts; the only way to obviate this is to permanently close up, as far as possible, all openings into the storm-water drains other than the regular catch-pits and close these latter by a tightly fitting and well secured cover during the dry season, and to disconnect any premises discharging sullage water into the storm-water drains.

XII. The Septic Tank Installation at Malabar Hill: here conditions have improved since the adoption of measures decided upon in consultation with the Drainage Engineer. The risk of recurrence of the nuisance would be further lessened by the covering in of the storage beds so as to present an arched surface upwards and provide for free removal of rain water.

XIII. The unpaved open spaces between rows of chawls: such areas are not dependent entirely on rainfall for their moisture; nahanis and wells allowed to fall into disrepair furnish an ample supply. Until these rain sodden patches of ground covered with pools and an immediate proximity to overcrowded houses are paved and drained under the authority of bye-laws, the filth and damp cannot be eliminated from the surroundings of the poor.

XIV. Private lanes and streets in the City, many of which, during the monsoon, are practically impassable and several in the heart of the City resemble lakes.

XV. The Reservoirs on Malabar Hill and in Mazagaon: both of these saturate the ground in the vicinity and afford countless breeding places. To use kerosine oil or pesterine for such is wasteful and also ineffective.

XVI. The open half channel rain water pipes under roofs, and junctions of two sloping roofs allowing the water to collect.

XVII. Imperfectly cleaned open half channel storm-water drains: especially in private premises they become choked with weeds and silt; the obvious remedy is to remove obstructions and permit water to flow freely.

The modern sanitarian is largely dependent on public support and interest in all measures affecting public health: these measures must of necessity be divided into public and private.

Private Measures:—Private individuals can do much, by seeing that no accumulation of water is allowed to remain in or near their houses by preventing waste and overflow of water, by seeing that all cisterns and tanks on their premises are properly covered; by cutting down rank vegetation where such exists, and in the case of gardens by seeing that no larvæ exist in the water tubs. In regard to wells a remedy has already been indicated. Many complaints regarding mosquitoes from private individuals have been found to be due to collections of water (containing larvæ) in old tins and chatties: small details of this sort are easily under the control of individuals. For those in a suitable financial position, the use of a small mesh mosquito curtain would result in a reduction of the chances of infection.

The use of quinine cannot be too strongly urged. Government have placed this remedy within the reach of all; and large employers of labour should be urged to press this measure.

The City is committed to large improvement schemes, which must take many years to accomplish, and side by side must occur a corresponding improvement in the habits of the poor. This can only happen as the result of popular lectures and of the manifestation of personal interest in their welfare. The City owes much to those who, under the auspices of the Sanitary Association, are quietly yet surely disseminating elementary hygienic principles among the poorer classes, and it is to such measures in the long run that we must look if an improved standard of living is to be attained.

Public Measures:—The Deputy Health Officers and Sanitary Staff are well acquainted with the various breeding places of mosquitoes, and diligent search is made by them in their respective Wards. But these places are so many and so universal that, considering the varied duties of the Sanitary Staff, only a portion of their time can be devoted to anti-malarial work. If mosquitoes are seriously to be combated, a determined and constant attack must be made on them and this can be done only by whole-time men.

There are also certain difficulties under which the Health Department has to work: first we have no power for ourselves to remove or remedy the hundred and one breeding places that exist in many compounds, etc. What is done is a

letter is addressed to those responsible, requesting them to remove the source of nuisance and meanwhile the larvæ found by us are destroyed and a constant watch is kept until the reforms demanded are complied with. Secondly, the wells in private houses can only be dealt with, compulsorily, through the Standing Committee. It is, however, a pleasure to record that many owners in the Fort area have voluntarily given permission to our staff to treat their wells with pesterine. This can only be a temporary measure, and a more permanent and effective method has already been described. Thirdly, the systematic treating of pools is a matter of considerable difficulty in the showery weather accompanying the conclusion of the monsoon, as the work done is liable to be nullified by a heavy fall of rain at a subsequent date. This cannot be obviated, however, as it would be impolitic to leave untreated a pool in which larvæ have been found. Fourthly, the extensive building operations going on in the City add considerably to the difficulties but, as far as possible, all such places are dealt with. Fifthly, the unlicensed bullock stables already mentioned.

Pamphlets are distributed to house-holders describing the various precautions that should be taken to prevent the breeding of mosquitoes, and in all Municipal Dispensaries the use of quinine as a prophylactic is urged ; this is also urged on all those who write to us complaining of the prevalence of Malaria.

A continuous campaign on the lines indicated will not only lessen Malaria, but will also remove other mosquito-borne diseases and contribute to the increased comfort of residents.

Our information of the cause of Malaria compared with our knowledge of the cause of other diseases is comparatively recent, and like many other discoveries hardly complete and somewhat variable, but working on the knowledge we have, a very large amount of work has been done in Bombay during the past 10 years.

The Corporation went keenly into the question of obtaining expert advice, and ultimately asked the Government to appoint a Committee and to depute an expert to consider the measures that should be adopted.

In January 1909, a Committee comprised of representatives of the Port Trust, Improvement Trust, Railways and the Chamber of Commerce and the Municipality was appointed and Captain McKendrick, I.M.S., deputed as expert Malariologist. Captain McKendrick was re-called and later on Dr. Bentley was appointed and in August Dr. Bentley submitted his report.

You all are now familiar with the able and exhaustive report on this subject by Dr. Charles Bentley, from which I give the following extract :—

" The Investigation into the distribution of Malaria within the City of Bombay has shown the disease to be prevalent over a very large area.

" In particular, it appears to be present in a persistent form in—

Ward A,
Ward B,
Ward C,
Ward D,
Ward E.

" It may be observed that it thus affects the most densely populated portion of the City involving an area with a population of over 6,50,000 people.

" It is not suggested that other parts of the Island are Malaria free, for this is very far from being the case, and there is evidence to show that cases of Malaria occur in practically every part of Bombay during certain times of the year, but it may be broadly stated that, in the above-mentioned areas Malaria exists to such an extent as to give indications of its presence throughout the year.

" The incidence of Malaria is especially marked along the whole of the east coast of the Island between Kasara, Basin, Mazagaon and the Sassoon Dock, Colaba, but it is also prevalent in the west coast, where a centre occurs in Walkeshwar in an area below the Malabar Hill reservoir.

" Broadly speaking, severe Malaria may be said to exist over an area including :—

Mazagaon—South of Gunpowder Road.

Tarwadi—South of Nesbit Road.

Dongri.

Umerkhadi.

Khara Talao.

Mandvi.

Chakla.

Market.

Dhobi Talao.

Esplanade.

North Fort.

South Fort.

Lower Colaba.

Portions of Walkeshwar.

" The population of this area numbers over 375,000 persons, or very nearly two-fifths of that resident upon the whole Island of Bombay, and out of this population the proportion actually suffering from Malaria must be very large.

" A recent microscopical examination made by myself of specimens of blood taken from nearly 700 residents in North Fort and Esplanade sections, a portion of intensely malarious area has shown that 35 per cent to over 50 per cent of the adults are infected with Malaria parasites, while among children the rate may be even higher.

" In one instance, in a mixed community of adults and children, the examination of 63 (46 adults and 17 children) showed that no less than 44 or nearly 70 per cent were harbouring the infection.

* * * * * * *

" These observations serve to give some idea of the amount of sickness produced by this disease within the City. As to the financial loss resulting directly and indirectly from this cause, no estimate can be given, but there is little question that it must amount to many lakhs of rupees annually. Such loss is necessarily very greatly increased when Malaria becomes epidemic as it has done in Bombay recently.

" But it must not be supposed that the disease was not present in considerable amount within the City previously. Enquiry shows that it has existed in certain parts of Bombay for many years and there is no likelihood of its dying out spontaneously. On the other hand, there appear to be grave reasons for believing that in the absence of organized measures for its suppression, the disease will persist, and may even extend and increase in intensity in certain localities from time to time ; while so long as it remains unchecked, the City will be exposed to the danger of epidemics similar to the one which has been witnessed during 1907-1908.

" Malaria presents in Bombay certain peculiarities both as regards distribution and propagation, which are in marked contrast to generally recorded observations in other parts of India.

" In this City, Malaria, which is generally considered to be a disease of scattered rural districts and tracts of jungle and unopened country, may be found widely distributed through densely populated areas, such as Chakla, Umerkhadi, and Khara Talao with populations of from 500 to over 600 persons per acre.

" The explanation of this fact is given by the study of the habits of the mosquito which serves as the common carrier of the infection in this City.

" For the species of Anopheles—Nyssorhynchus Stephensi, which serves to propagate Malaria within Bombay, is found to breed readily in wells, cisterns, tanks, tubs, and in fact in almost any conceivable receptacle for water—natural or artificial—whereas in many places, where other varieties of Anopheles are concerned, only natural breeding places such as streams, ponds, ditches and puddles are dangerous.

" These facts have a considerable bearing upon the problem of Malaria prevention for Bombay, but it appears to me that organized and systematic mosquito destruction will afford a means of controlling the disease within definite limits and, provided it is carried out with due care, should reduce the liability to epidemic manifestations, or even entirely prevent their occurrence.

" It must not be supposed that the task of mosquito destruction to an extent sufficient to actually control Malaria will be an easy one. But given a proper staff and organization, adequate powers, and sufficient expenditure, I believe it will be quite possible to obtain the desired results.

" I wish to make it clear from the outset that, in my opinion, in order to deal with the matter effectively, it will be necessary to create a special department engaged solely in mosquito destruction, and working under the control of the Executive Health Officer.

" Such a Department must be a permanent one and must possess a small regular staff of skilled men, whose sole duty all the year round must be anti-mosquito work. In addition, arrangements must be made for increasing the staff by the addition of unskilled men during the period between the outset of the rains and the complete establishment of the dry season.

" In this short memorandum it is impossible to go into details which will require careful discussion. But I would suggest, as a tentative measure, that steps be taken to organize such a department for immediate work in Wards A and B, and possibly Walkeshwar, with a view to subsequently extending operations over the whole southern portion of the City, south of a line drawn between Kasara Basin, Mazagaon and Mahaluxmi Battery, and possibly in other parts of the Island."

In another letter Dr. Bentley drew attention to the dangerous state of the wells, private and public, within the area of the Fort North.

" A careful examination " he wrote—" has been made of 511 wells within this section with the following results :—

" 1. 240 have been found to contain very numerous larvæ of Anopheles mosquitoes.

" 2. 32 of these contain larvæ of Culex or Stegomyia in addition.

" 3. A total of 83 wells have been found to contain larvæ of either Culex or Stegomyia mosquitoes.

" It is stated by a large proportion of householders that many of these wells are unused. In a few cases wells have been discovered, whose existence was unknown to the present occupiers of the houses in which they were situated.

" Many occupants of houses, with mosquito infected wells, complained of being troubled with mosquitoes, but few, if any, appeared to know that the source of their trouble was the open or improperly guarded well in the house itself. A certain proportion of wells are provided with wooden covers, but many of such covers are useless and in other cases there is evidence that they are frequently left open. A few wells have been found blocked up and in certain cases, particularly in the neighbourhood of Frere Road, wells have been treated recently with pesterine and are free from mosquito larvæ.

" Among the 240 wells infested by the larvæ of Anopheles, nearly every one is found to be the breeding place of Nyssorhynchus Stephensi, a most dangerous carrier of Malaria.

"The few exceptions show the presence of Mysomyia Rossi.

"It has been shown experimentally that this species of Anopheles can be readily infected with Filaria, and in all probability it is one of the agents in the propagation of Filarial disease.

"In the course of the present investigation, adult mosquitoes of this species, that have been caught and examined in order to test the possibility of their serving as carriers of Malaria, have been found to be very heavily infected with Filarial embryos.

"In this connection it may be remarked that certain common species of Culex mosquito are known to be also concerned in the transmission of Filarial disease, and among the 83 wells, which contain other than Anopheles larvæ, Culex mosquitoes of this kind are to be found breeding. A certain proportion of the wells contain the larvæ of Stegomyia Calopus (formerly known as Stegomyia Fasciata), the species of mosquitoes concerned in the propagation of Yellow Fever in the Western Hemisphere.

"Enquiry shows that Malaria has been present in the North Fort Section for many years, while a reference to past history reveals the fact that for generations this portion of the City has suffered from the evil effects of "dangerous miasmata." It is certain that Anopheles mosquitoes must have existed in this part of Bombay for a very long time, and it is probable that their distribution has been extended from time to time.

* * * * * * *

"A recent examination of 2,782 children, resident in the Fort, revealed the fact that 40·9 per cent were suffering from enlarged spleen. This compares very unfavourably with the result of an examination of 2,721 children in Wards F and G, among whom only 1·4 per cent showed splenic enlargement.

"A more recent microscopical examination of the blood of 170 persons resident in Fort North showed no less than 78 to be infected with Malaria parasites. The people examined included 57 adults and 113 children. Of the adults 28 were infected, and of the children 49. Among the children a considerable number had been undergoing quinine treatment, or, the proportion of infections would undoubtedly have been much higher. It may be mentioned that for the purposes of this examination, no selection of cases was made, blood films being taken from any persons who were willing.

"These observations show that the present sanitary condition of North Fort, especially as regards the existence of such an extraordinary number of unguarded wells, is a menace to the health of the whole City. For the danger resulting from the continuous breeding of such large number of mosquitoes is not confined to residents in that locality only. There are many wells in other parts of the City, at present free from mosquitoes, but sooner or later they will become infected if dangerous centres such as those in the North Fort are permitted to remain unchecked, and so long as this is the case the whole City must necessarily be exposed to the danger of recrudescences of epidemic Malaria.

"In my opinion, there should be no delay in taking adequate steps to control this danger.

"All unused wells should be filled in as soon as possible. Those that are required for use should be provided with permanent covers suitably designed, and arrangements made for raising the water, by means of a hand-pump. The depth of no well that I have seen would preclude the use of a simple suction pump.

"It is probable that the most suitable form of covering would be a permanent cover of re-inforced concrete.

"The cost of protecting these wells efficiently need not be great, while the benefit to the health of the residents in the locality will be enormous. Moreover, a constant source of danger to the whole of the City will have been removed.

" It must be remarked that it will not be sufficient to protect the wells in which larvæ are at present breeding. There are probably millions of adult mosquitoes already existing in the Fort, and as soon as their favourite breeding places are abolished, numbers of these will seek other suitable locations. This being the case, it will certainly follow that any well in the neighbourhood to which they can obtain access, if not already infected, will speedily become so. In addition it is more than likely that a far larger proportion of wells actually harbour mosquito larvæ than has been shown in the course of the present inquiry, for unless they are present in very large numbers, it is exceedingly difficult to dip them out with either a bucket or a net, and in many cases the water can be reached in no other way.

" In my opinion, a well which serves as a breeding place for mosquitoes should be declared a dangerous nuisance and a house which contains a well, in which Anopheles mosquitoes are allowed to breed, should be declared unfit for habitation.

" In conclusion, I beg to point out that it is my belief that until steps have been taken to remedy the condition of the wells in Fort North, all other forms of anti-malarial sanitation within this area will be rendered futile, and moreover the continued existence of numerous uncontrolled breeding places of Anopheles in this locality will tend to annul efforts at mosquito destruction in adjoining areas."

Conditions favourable to Malaria in Bombay :—The factors which conduce to endemic Malaria are all present in Bombay :—

1. *The Mosquitoes* :—At present as far as our knowledge goes—there are 7 Anopheline mosquitoes to be found in the Island of Bombay—6 of which are Malaria bearing—the 7th a Rossi is said not to be.

2. Breeding places are limitless—open wells, tanks, cisterns, new works, reclamation, open channels and low-lying lands.

3. *The people* :—75 per cent of the people are of the poor and illiterate class, ignorant and superstitious, living under indifferent sanitary conditions—passively resistant and reluctant to take advantage of our sanitary measures : the majority coming from malarious districts outside Bombay and returning to them yearly.

The population is augmented by large numbers of people coming for work or food. Large works are constantly in progress and there is a great demand for labour.

The cry of religious susceptibilities is heard amongst the educated as well as the uneducated, where sanitation interferes with their prejudice or purse.

4. *Climate* :—The climatic conditions are every way favourable to the breeding of mosquitoes.

5. *Position* :—Bombay is situated adjoining the main land and the larger Island of Salsette which are ideal breeding places and where Malaria prevails.

Thousands of persons enter the City daily and return in the evening to the suburbs, which are very malarial.

Major Liston in a paper read on " *Malaria in Bombay* " said :—

" There are four ways by which it is possible to ascertain to what extent Malaria is present in a particular place. We may, firstly, scrutinise the Vital Statistics, or secondly, we may examine the children of the place, observing to what extent enlargement of the spleen is present among them. Thirdly, we can examine microscopically the blood of the children living in the locality and note the number which harbour Malaria parasites. Fourthly, we can seek for Anopheles in the district noting the species, and especially the number which show Malaria parasites in their bodies.

" It was difficult to obtain reliable statistics of the extent to which Malaria prevailed, for accurate records had not been kept in the past. Many cases of the disease, however, came to our notice and I may mention particularly three

cases of that grave and fatal form of the malady known as Cerebral Malaria. These cases all occurred within a period of three weeks. But I am in a position to give some figures which carry with them some force ; they have been kindly supplied to me by the Superintendent of the P. and O. Company. He writes: " Each steamer, after being in the Victoria or Prince's Docks for a few days, returns its cases of Malaria with painful regularity and not only does the sickness last the whole time the ships are in port here, but the fever appears to be of such a malignant character that it continues throughout the whole voyage to London and consequently incapacitates a large number of our crews from re-joining their vessels there. This state of things has become so serious, that my General Managers have telegraphed to me from London that cases of Malaria are increasing to an appalling extent amongst the crews of the Bombay mail steamers, the 'Arabia,' which sailed from Bombay on the 1st of August last, having had 82 cases on the homeward voyage ; the 'Persia,' which sailed on the 15th idem, landed 100 cases in London, and a similar number occurred on the 'Marmora,' which left on the 29th August. This will give you some idea of the seriousness of the epidemic."

" Secondly, we have examined a considerable number of the children living in Frere Road in order to ascertain to what extent enlargement of the spleen prevailed among them. No less than 80 per cent. of the children suffered in this way. Thirdly, a microscopical examination of the blood of a number of children was made, which revealed the fact that as many as 50 per cent of them were harbouring the Malaria parasite.

" Fourthly, we collected a number of mosquitoes in the neighbourhood : we observed that Anopheles were abundantly present. An examination of these showed that two species were found, *viz.*, Anopheles Rossii and Anopheles Stephensi. Now the former can be captured all over Bombay ; moreover, it has been examined in large numbers on many occasions, but has never been observed to be infected in nature, so that this mosquito did not seem to play any part in spreading the disease. Anopheles Stephensi, on the other hand, has never been found by me in Bombay before. It has since been captured only within the limits of the present epidemic area.

" We have dissected a large number of these mosquitoes, caught chiefly in the Frere Road ; nearly 25 per cent of them harboured the Malaria parasite in some state of development. This discovery is particularly interesting, not only because it is the first time that this mosquito has been observed to be infected in nature, but also because the other species which have been found infected in India, *viz.*, Anopheles Listonii and Anopheles Culicefacies have been mosquitoes which breed in flowing water, in streamlets and irrigation canals, while this mosquito, Anopheles Stephensi, generally breeds in still water, in wells, in cisterns, in chatties, and in tin pots. Moreover, it assumes an additional interest in view of the fact that the present epidemic seems to be associated in some way with the construction of the new Docks. Earthworks of this nature have very often been associated with severe Malaria, and, if for no other reason than to guard against such eventualities in the future, the present epidemic ought to be thoroughly investigated.

" I have said that this epidemic of Malaria is associated with the presence of two species of Anopheles, the one harmless, while the other is responsible for spreading the disease. It is of importance therefore, to distinguish these mosquitoes from one another. They can be differentiated from one another in the stages of imago, larva and egg. The fully developed mosquitoes, as you will see, somewhat closely resemble one another, but a more careful inspection will reveal the fact that Anopheles Stephensi is rather greyer than Anopheles Rossii which has a somewhat brownish hue. With the naked eye, or a hand lens, you can readily observe that the marking on the palpi of the two mosquitoes differs. Anopheles Stephensi has two broad white bands towards the tips of the palpi separated by a narrow dark band ; while Rossii has a single broad white band at the tips of the palpi followed by a dark band, which again is followed by a narrow light band. The legs of Anopheles Stephensi too are speckled, especially the tibia and femora, while this is not the case with Anopheles Rossii. The

larvæ can be distinguished by the shape of the leaflets of the palmate hairs, the terminal filament of each leaflet in Rossii is very long. The eggs of the two species differ. In the case of Stephensi, the lateral floats encroach upon the deck surface of the egg, so that this surface has the shape of a figure of 8. The floats in the egg of Rossii are placed well down upon the lateral surfaces.

" Let us now see whether the favourable conditions necessary for the multiplication of the Malaria parasite are to be found in the infected area. First, the conditions suitable for the transference of the parasite from man to mosquito are fulfilled in the abundant presence of a suitable species of Anopheles, *viz.*, Anopheles Stephensi and in the presence of a human population suitably infected."

Measures now adopted in Bombay.—Since April last, a Special Malaria Department has been started, under my supervision, under the control of a Special Malaria Assistant, who is one of my Senior Deputy Health Officers, who has long practical experience in the Health Department and who is a Diplomate of the Liverpool School of Tropical Medicine. The staff provided under him consists of four Inspectors on a salary of Rs. 125 to 150, who are fully qualified medical men ; two of whom hold the degree of Bachelor of Hygiene and a third has studied in the London Tropical School ; 38 Sub-Inspectors 20 on Rs. 40 and 18 on Rs. 35 and 81 Begaries on Rs. 11.

The Special Assistant has been provided with a separate office and five clerks, one Laboratory Assistant and four peons.

A laboratory has also been provided, with two microscopes, two dissecting microscopes and other necessary appliances.

The four Inspectors and one Sanitary Inspector supervise the work of the Sub-Inspectors, and their offices are in the Municipal Charitable Dispensary Buildings.

The two wards in the North of the Island have got one Sub-Inspector each, and their work is supervised by their respective Deputy Health Officers.

The principal five wards of the City proper contain 27 Sections and each Section is in charge of a Sub-Inspector, except the Sections of Fort North, Market and Chukla, which are highly infected quarters and which contain many wells.

There are in all 4,380 wells, 166 tanks and 4,887 cisterns, approximately, in the City of Bombay, as shown below:—

—	A. Ward.	B. Ward.	C. Ward.	D. Ward.	E. Ward.	F. Ward.	G. Ward.	Total.
Wells	688	498	755	881	358	332	768	4,380
Tanks	58	3	4	10	27	37	27	166
Cisterns	2,409	460	106	872	948	29	63	4,887

The Sub-Inspectors have been distributed in such a way that each house can be revisited every 7 to 15 days according to the importance of the locality.

For the first three weeks the Malaria Staff was coached up in the routine work and in the method of inspecting larvæ in wells, tanks, etc. By this time these men, and majority of coolies, know the places where larvæ can be detected and the two main differentiations of Anopheles and Culex.

Each Sub-Inspector has been supplied with the following complete set of implements for examination :—

1 Ring net with rope.

1 Zaree.

1 Hand net.

1 Tin hand-pump.

1 Enamel cup.

1 ,, spoon.

1 ,, pan.

1 Bucket with rope.

1 Ladder. In addition to Quinine bottles and Winchester quarts for sending samples of larvæ and water,

Malarial cards of different colours for each ward, *viz.*,

A Ward. White,
B ,, Red,
C ,, Pink,
D ,, Blue,
E ,, Yellow,
F ,, Orange,
G ,, Green, and containing the following particulars have been supplied to each ward :—

Malaria. _____Ward.

Public Health Department, Bombay.

_____Ward._____Section._____Street.

House No _____Name of Owner._____

Class of occupier._____

Type of closet_____

Position of cisterns_____Larvæ present?_____

Position of well_____Larvæ present_____

Date of 1st inspection _____

Date of Notice. _____

Date of 2nd inspection._____

Date of action._____

Result of action taken :—

Subsequent inspection and remarks.

*Name of Inspector*_____

The procedure is for the Sub-Inspector to fill in a card for each and every house in his beat, entering therein whether any larvæ are found and of what variety. This card is then sent to the Head Office, where the Special Assistant Health Officer writes a letter to the party to hermetically cover the well, or the cistern as the case may be. If this is not complied with, a reminder is sent after 15 days and if nothing further is done, the water in case of wells is sent to the Municipal Analyst for Chemical examination and the well is then reported to the Municipal Commissioner for the sanction of the Standing Committee under Section 381 of the Bombay Municipal Act of 1888 as amended. Subsequent visits of the Sub-Inspectors are entered at the back, so that we can easily ascertain after how many days a particular house was visited.

In addition to the cards, we have also a Mosquito Record Book or a Mosquito Street Register, which shows at a glance the Mosquito record for each and every house in the City.

Spot Maps have been kept in each Ward, for each Section showing the position of the wells, and cisterns, etc., breeding larvæ either of Culex or Anopheles, in different colours.

I may here state that we have decided to take action both for Anopheles of all varieties and also for Culex.

Under the existing Section 381 of the Act, we have no power to take legal action for hermetically closing cisterns. This section of the Act is being revised and we hope to get final sanction of the Bombay Government in about 2 or 3 months time.

The Act as proposed to be amended will run as under :—

" *Section 381.*—(1) " If, in the opinion of the Commissioner—

(*a*) Any pool, ditch, tank, pond, well, quarry hole, drain or water course, or

(*b*) Any cistern, water butt or other receptacle for water, whether within or outside the building, or

(*c*) Any land on which water accumulates and which is situated within a distance of 100 yards from any building used as a dwelling house,

is or is likely to become a breeding place of mosquitoes or in any other respect a nuisance, the Commissioner may, by notice in writing, require the owner thereof to fill up, cover over or drain off the same with such materials, and in such manner in all respects, as the Commissioner shall require, or to take such other action with the same for removing or abating the nuisance as the Commissioner shall prescribe.

(2) " If an owner, on whom a requisition has been made under sub-section (1) to fill up, cover over or drain off a well, shall within the time prescribed for compliance therewith, deliver to the Commissioner written objections to such requisition, the Commissioner shall report such objections to the Standing Committee, and shall make further enquiry into the case and he shall not institute any prosecution under Section 517 for non-compliance with such requisition, except with the approval of the Standing Committee ; but, subject to the proviso hereinafter contained, the Commissioner may, nevertheless, if he deems the execution of the work called for by such requisition to be of urgent importance, proceed under Section 489, and cause such well to be hermetically covered over, pending the Standing Committee's disposal of the question whether the said well shall be permanently filled up, covered over or otherwise dealt with, and the Commissioner shall in every such case determine, with the approval of the Standing Committee, whether the expenses of any work already done as aforesaid shall be paid by such owner, or by the Commissioner out of the Municipal Fund, or shall be shared, and if so in what proportions.

" Provided, however, that if the Commissioner shall be satisfied, as the result of such further enquiry, that the water of such well is used for religious purposes, he shall by license permit such owner to continue the use of such well

for such purposes, but subject to such restrictions and conditions as may be prescribed by such license, and subject also to the power of the Commissioner to suspend or revoke such license if any of its restrictions or conditions is infringed or evaded."

New Section 381-A. (1).—" No new well, tank, pond, cistern or fountain shall be dug or constructed without the previous permission in writing of the Commissioner.

(*a*) The Commissioner may by written notice require the owner, or other person, who has done such work to fill up or demolish the work in such manner as the Commissioner shall prescribe, or

(*b*) Grant written permission to retain such work, but such permission shall not exempt such owner, or person aforesaid, from proceedings in respect of such contravention."

This still gives the final control for legal steps into the hands of the Standing Committee which must necessarily cause delay, as parties are in the habit of making endless appeals to that body.

Pending the amendment of the Act, we have been adopting persuasive measures, by means of advertisements and distribution of leaflets, but I am sorry to say this has not much effect.

A list of places where mosquitoes are found is published weekly in the press and post cards are sent to every house where larvæ are found with particular instructions. We are also distributing leaflets on Malaria (copy attached herewith), enlightening the public as to how Malaria is spread and what precautions ought to be taken. We also deliver public lectures in schools and other places with the help of magic lantern slides specially prepared by the Health Department.

As regards wells, we experience a great deal of difficulty, owing to religious objections raised by the public. We allow wells to be hermetically covered with or without trap doors. Wells which are close to privies and contain water polluted with sewage are ordered to be filled in.

The trap doors are allowed only in cases where there are strong genuine religious objections and then too after personal enquiries, either by the Municipal Commissioner or myself or my Assistant.

The covering approved by the Health Department is of two kinds—

(1) One kind of cover is made of wire gauze of 20 meshes to a running inch, and covered over on the top with expanded metal so that the gauze underneath may be protected. With this sort of cover a trap door under lock and key or a hand pump is allowed, if the water is required for religious observances, washing and similar purposes. These covers cannot last long on wells in open compound, as the gauze is likely to break in the monsoon with the force of the rain and is likely to rust.

To obviate this difficulty we have another variety of cover in which the whole surface of the well is covered over with brick, etc., and cement except a small opening of 1½ to 2 square feet which is covered over with trap door either of wire gauze or wood. These trap doors are allowed under one condition, *viz.*, that they should be kept under lock and key and opened only when water is actually being drawn out.

Persons who hold very strong religious objections prefer wire gauze covers as they say that sun light must play on the well water.

Before enforcing hermetical covering over wells, a trial is given to Khajura fish. In many cases this fails, as the waters are not kept free from leaves and other shrubs.

Apart from religious objections, sentimental objections are raised to covering the wells. I give herein extracts from 2 letters, which show the difficulties we have to contend with, in our City :—

1. One owner writes as follows :—

" There is a superstition connected with the well. It is well-known all over this part of the Town that the well is said to be a sacred well and much sanctity is attached to it.

" Out of deference to the superstition, I had in designing Alice Buildings to so design it as to leave the well alone.

" To me personally the well is of no use, but those who believe in the superstition come and pray near the well and present offerings of flowers and cocoanuts to it.

" Under these circumstances, I cannot fill up the well nor can I have it covered over by wire hermetically."

2. Another writes *re* a well at Khetwadi Main Road as follows :—

" My client has also a religious objection to the filling up of the said well or to its being hermetically closed, namely, that my client and his family believe that there is a saintly being in the said well, and they always personally see the Angelic form of the said being moving in the compound at night and they always worship the said being in the well and they have a bitter experience of filling the said well or closing it up hermetically ; because in or about the year 1902 my client did actually fill up the said well to its top, but on the very night on which it was so filled up all the members of my client's family fell dangerously ill and got a dream that unless the said well was again reopened and kept open to the sky they would never recover. The very next day thereafter, they had again to dig out the earth filling the said well and they recovered only when the said well was completely opened up to the sky."

The Parsee community questioned the figures of spleen-rate among the Parsees as given in Dr. Bentley's report. They therefore appointed a Committee of their own medical men, who after subsequent examination of medical men of their own choice, confirmed Dr. Bentley's conclusions.

Steps are being taken by our Municipality for hermetically covering all cisterns in Municipal Buildings and also cisterns over public latrines and urinals and the Government Executive Engineer is also taking measures for cisterns over Government Buildings.

The Port Trust areas including the Docks, the two Railway premises, the military quarters in Colaba, Marine Lines and Carnac Road, and City Improvement Trust grounds are looked after by a special staff kept by these bodies and we exercise no supervision over them.

As regards the two reservoirs, we are arranging to hermetically cover the filter beds and reservoirs at Malabar Hill, and the question of hermetically covering the filter beds at Bhandarwada is still under consideration.

Places where there are temporary pools or puddles during the monsoon are freely treated with pesterine by a Success Sprayer costing about Rs. 60.

There are, however, a large number of such places where water collects and breeds mosquitoes, *viz.*, hollows in machinery, water in boats, etc.

In order to ascertain the prevalence of Malaria and the effect of the measures adopted, we have adopted the following three methods :—

(1) Blood slides of patients suffering from Malaria or any fever and attending the 12 Charitable Municipal Dispensaries, are examined in the Malaria Laboratory.

(2) Spleen census of children between 1 and 16 years is taken in Municipal Health Department chawls and in other big chawls occupied by the labouring class of people.

(3) A census of Anopheles distribution is taken and all specimens of Anopheles sent by the Sub-Inspectors are examined and classified under different varieties and sent to the Parel Laboratory.

As regards the dissection of mosquitoes and identifying the particular varieties that convey Malaria, Liston and Bentley have made considerable researches, but there is much still to be done is this direction—especially determining how far the present information is correct; as, with all due deference to the enthusiasts working on mosquitoes, the varying information supplied to the sanitarian is conflicting.

In 1901 the Stephensi was said not to be mosquito bearing, and although present in Bombay, was not counted as a dangerous factor.

In 1908 Liston and Bentley said that they found Stephensi breeding in pools and collections of water in the Docks in certain varieties and that it was the only mosquito to be reckoned with; and that all Malaria preventive measures should be directed to places where Stephensi breed and all other efforts were waste of time and money.

The mosquitoes chiefly prevalent in Bombay are the following:—

(1) Nysso-myzomyia rossi.

(2) Neocellia Stephensi.

(3) Myzorhynchus barbirostris.

(4) Myzomyia listonii.

(5) Myzomyia culcifacies.

(6) Nyssorhynchus Jamesii.

(7) Nyssorhynchus fuliginosus.

Except Rossi all convey Malaria.

Government having started a Stegomyia Survey in Bombay, my Malaria Department send to the Parel Laboratory samples of all larvæ found daily in the City. In all 1,050 samples were sent.

As regards fish, we have invited tenders so that people who wish to give a trial to Khajura fish may get the right kind and at a moderately cheap rate.

As regards quinine, it is freely given in all fever cases in our Municipal Charitable Dispensaries and we have got a scheme in hand to distribute freely tabloids of Burroughs Welcome & Co., in selected chawls and institutions, where the drug can be given under the supervision of a responsible person.

I append herewith a statement showing the work done by the Special Malarial Branch from its start up to the end of September last.

Statement showing the work done by the Malaria Branch from the 15th April 1912 to 30th September 1912.

No. of houses inspected by the Inspectors	8,345
„ „ „ Sub-Inspectors	77,189
No. of wells hermetically covered	280
„ filled in	32
No. of new requisitions addressed to parties	1,117
No. of cases in which the sanction of the Standing Committee for further action was applied for	112
No. of cases in which sanction of the Standing Committee was obtained for further action	165
No. of lectures delivered to the public	9

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308 requisitions have been carried out without resort to legal measures. The following table shows the number of patients attending our Municipal Charitable Dispensaries for Malaria fevers:—

Statement of Malaria cases treated in the Municipal Charitable Dispensaries during 1912—from January to September.

District No.	Cases treated in									Total.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	
1	300	274	276	278	353	301	319			
2	31	18	8	8	10	8	19			
3	40	48	40	27	55	38	50			
4	36	19	3	9	2	8	8			
5	52	43	38	32	40	47	62			
6	58	13	9	10	20	14	26			
7	12	29	4	...	2	6	...			
8	52	47	69	56	68	86	97			
9	52	68	41	35	27	69	60			
10	55	53	38	29	19	27	32			

I give herein by Wards and Sections the result of the spleen census and the blood slides examined by the staff up to September last:—

Ward.	Sections.	Date when taken.		No. of children examined.	No. with enlarged spleen.	Percentage of children with enlarged spleen to No. of children examined.	Remarks.
A	Lower Colaba ...	September	6	44	3	6·81	
...	Do. ...	„	6	27	1	3·70	
...	Do. ...	„	6	17	...	0·00	
...	Fort North ...	„	5	64	25	39·62	Municipal Halalkhou's chawl.
...	Do. ...	„	5	55	9	16·36	Municipal Bigari's chawl.
...	Do. ...	„	5	45	11	24·44	Ditto.
...	Esplanade ...	„	3	110	23	29·90	Ditto.
B	Umerkhadi ...	„	9	15	1	6·66	
...	Do. ...	„	9	25	3	12·00	
...	Do. ...	„	19	146	15	10·27	
E	Tarwadi ...	„	2	104	40	38·46	Hindu Orphanage.
...	Kamathipura ...	„	28	69	5	7·24	
...	Tardeo ...	„	25	26	2	7·69	
...	Do. ...	„	25	58	5	8·62	
...	Do. ...	„	30	170	24	14·11	

The total amount of anti-malarial work done in the different Wards of the City during the year 1911 is summarised in the table below:—

		Number.
i.	Wells examined for mosquito larvæ	2,411
ii.	Cisterns ditto	4,632
iii.	Tanks ditto	179
iv.	Wells in which larvæ were found	1,440
v.	Cisterns ditto	308
vi.	Tanks ditto	49
vii.	Cases in which requisitions were addressed to parties	482
viii.	Ditto were complied with ...	222
ix.	Cases reported as "most objectionable" ...	117
x.	Notices issued against parties	154
xi.	Notices complied with	66
xii.	Prosecutions undertaken	70
xiii.	Wells hermetically covered	183
xiv.	Wells filled in	70
xv.	Tanks filled in	1

To recapitulate, the measures adopted are:—

(1) Closing of wells and cisterns breeding larvæ.

(2) Treatment of all temporary pools and puddles with pesterine.

(3) Giving a trial to fish before taking legal steps.

(4) Distribution of quinine.

(5) Filling in all hollows and low grounds with a view to remove potential sources of mosquito-breeding and to improve sanitation generally.

(6) Improving of drains and gullies and extension of drainage schemes to the north of the Island.

(7) Improving of the general conservancy of the City.

(8) Teaching the public by handbills, and lectures with Magic Lantern slides.

(9) Taking action in Court in cases where parties defy the Municipality.

(10) The spleen census of children and the examination of blood of patients attending dispensaries.

(11) A weekly return of cases of Fever from all private and public dispensaries.

(12) The examination of all species of mosquitoes found at different times of the year.

(13) We have a scheme in hand to fill in a portion of the foreshore on the Nepean Sea Road, and Government contemplate reclaiming a large part of the foreshore in the south of the Island. This will remove the existing nuisance.

The larger scheme for reclaiming and filling in and draining all low-lying areas in this Island will take time before being dealt with and this is being strongly urged. The system of open drains and channels which have been constructed for draining these areas is of itself a danger and, although both Bentley and Liston say these channels and any large tanks do not breed Anopheles Stephensi—a Malaria bearing mosquito, I fear that this opinion will have to be seriously modified before long.

The task before us is, as can be seen, no light one. Apart from the passive resistance of the people, educated and uneducated, we have to face an enormous expense and many difficulties before we can say Bombay is Malaria-Free.

LEAFLET.

Hints for the Prevention of Malarial Fevers.

It is the duty of every one employing labour :—

1. To improve the condition of their servants' houses and to see that they are not unduly crowded.

2. To see that their compounds and the surroundings of their houses are kept as clean as possible, special attention being paid to the clearing away of old tin pots and pans, rank vegetation, manure and refuse.

3. To fill up or drain all small pools, ponds and collections of stagnant water near their houses.

4. To see that all cisterns and tanks and wells are properly covered.

They should also be requested to use their influence among their friends, neighbours and acquaintances to the end that these may follow their example.

The Malaria parasite is conveyed by a species of mosquito.

Precautions to be taken inside the house.

1. The proper use of the mosquito net is the best and surest prophylactic measure that we have. The net should be of a small mesh and should be tucked in carefully all round the bed. If rods are used it should be hung inside them. But mosquito nets are not available for the poorer classes who suffer most.

2. During the rains and whenever fever is prevalent, each member of your household, including your servants, should get 15 grains of quinine a week. The money will be well spent, in that it prevents fever occurring among the members of your household and being conveyed to others by the mosquitoes.

3. The general cleanliness of your house should receive much attention. It is found that mosquitoes rest in dark and dusty corners. The cleaner the house the fewer the mosquitoes. Bins or boxes should be provided for household refuse which will be supplied by the Health Department.

4. It is advisable to have as few curtains and as little drapery in a house as possible, as they harbour mosquitoes. Curtains should be light in colour and of a washable material.

5. With regard to children on their going to bed, it is advisable to anoint their legs, arms, foreheads and necks with oil of eucalpytus, or menthol and vaseline or carbolic oil, and also when washing them, to use turpentine soap, as such measures tend to keep off mosquitoes.

6. Careful attention should be paid to water receptacles in bath-rooms, and around the house. It is not advisable to keep "gurrahs," or "chatties" full of water in a bath-room. Those in use should be emptied daily. Special attention should be paid to the "gurrahs," kept for cooling soda water.

Precautions to be taken outside the house.

1. Small "kutcha" ponds and ditches exist in many gardens and compounds in India, and are generally the breeding places of mosquitoes, which when mature readily fly into the house. These ponds are often made by the landlord when he repairs the stables or servants' houses. Therefore, one of your first measures should be to have all ponds and ditches near your house filled up.

2. Frequently, there lie near the kitchen and outhouse old pots, kerosine tins, and other receptacles for water; a careful search for these should be made and, if found, they should be removed or destroyed.

3. The next point which should receive your attention is the surface drainage round the house. Frequently, only "kutcha" surface drains are found. When these are out of repair, stagnant water will accumulate during the rains. To obviate this, good small "pukka" surface drains should carry the water well away on every side.

4. A systematic weekly inspection of the vicinity of the kitchen, servants' houses and compound generally should be made.

5. The surface drainage round the mouth of the compound well is often very bad. Waste water accumulates there and anopheles pools are thus formed. You should therefore get a good "pukka" surface drain to carry off all waste water from the well and distribute it to the garden. The well should be protected by a close fitting cover.

6. The system of flower garden irrigation tends to form pools where mosquitoes can breed. It should not therefore be carried out close to the house, and any small tanks or reservoirs in the garden when not in use should be treated with half a tumblerful of crude Petroleum Posterine once a week, as this procedure stops the development of mosquitoes in them. These tanks should be covered with close fitting covers. All garden irrigation should be carried out by means of "pukka" masonry channels. All fountains should be supplied with fish.

7. Excessive vegetation and undergrowth should not be allowed to exist near the house. Anopheles mosquitoes prefer cool, dark places for resting in during the day, so that excessive vegetation should be cleared away from near the doors and windows of sleeping rooms.

8. It is important to pay attention to the cleanliness of your servants' houses and their vicinity. Native servants frequently suffer from fever, and mosquitoes haunt their dark ill-ventilated houses. The following points need attention :—

1. There is frequently a ditch or pond near the servants' house, where the mosquitoes breed. This should be searched for and filled up.

2. The houses of servants, especially menial servants, syces and grass-cutters, are frequently overcrowded. As few servants as possible should be allowed to live in the compound.

3. Servants' houses should be thoroughly cleaned out and fumigated with sulphur once a month and whitewashed twice a year. Personal attention to the surroundings of your servants will well repay the trouble, as you will not only have healthier and happier servants, but the members of your family will run less risk of catching fever.

Malarial Fever is conveyed by Anopheles Mosquitoes after biting a person suffering from Malarial Fever.

THE MOSQUITO lays eggs on any accumulation of water, however small, inside or outside the house, water in wells, empty flower pots, roadside pools, catch pits, choked gutters, etc.

THE EGGS look like pieces of soot on the water.

THE EGGS hatch out into Larvæ in 48 hours (Fig. 1).

THE LARVÆ look like small pieces of stick lying on the water until disturbed when they swim away backwards and sink to the bottom.

THE LARVÆ become Pupæ about a week.

THE PUPÆ become Mosquitoes about 48 hours afterwards.

THE MOSQUITO flies away to suck the blood of man or animal and returns to some water to lay eggs every few days, depositing several hundreds.

If the Mosquito sucks the blood of a person suffering from Malaria and bites a healthy person, the disease is conveyed, and 12 days after the healthy person may take an attack of fever.

PRECAUTIONS:—Prevent the Mosquito breeding by getting rid of accumulations of water. Prevent the access of Mosquitoes to the water, or use Pasterine or Crude Petroleum to sprinkle over the water every 7 days. Take 15 grains of Quinine weekly and give 15 grains of Quinine weekly to your servants and children, during the Malaria season.

PUBLIC HEALTH DEPARTMENT,
BOMBAY MUNICIPALITY,
Bombay, 18th June 1912.

J. A. TURNER, M.D., D.P.H.,
Executive Health Officer.

PROGRESS OF PRESENT ANTI-MALARIAL SCHEMES IN THE UNITED PROVINCES

Major J. D. Graham, I.M.S., Special Malaria Officer, United Provinces.

As a result of the pecuniary grant by the Government of India towards matured schemes in the United Provinces after the Imperial Malarial Conference at Bombay in November 1911, the three projects of Nagina, Saharanpur and Kosi were taken up.

Surveys of Nagina and Saharanpur had been completed in 1909–10 by Major J. C. Robertson, and of Kairana and Kosi by Major Graham in 1910–11 and all have been reported on to Government.

For various reasons, chief amongst which were its situation on the Khadir and its relative unimportance, Kairana was ruled out. Local committees, presided over by the respective Collectors, and having the Sanitary Engineer to Government, the Sanitary Commissioner, and the Special Malaria officer as members in addition to the local Executive Engineers (Irrigation Department) were constituted for the three places, Saharanpur, Nagina and Kosi and these having met early in May 1912, considered the reports of the Special Malaria officer and prepared schemes with estimates for the carrying out of the projects as outlined in the Special Malaria officer's recommendations. These schemes have since been elaborated into definite engineering projects by the irrigation department and other departments concerned and I propose now briefly to consider each, and to show to the meeting the actual details of each as it at present stands, with a view to enabling the members to form some idea of the value of such completed projects, when subsequently investigated, in determining if the actual benefits are commensurate with the expense of the adoption of the various anti-malarial measures recommended in the original reports of the Special Malaria officer.

The problems involved in the three places may briefly be stated as—

(1) In Nagina, tanks, waterlogging and wet cultivation.

(2) In Saharanpur, over irrigation by canals, water logging, and wet cultivation.

(3) In Kosi irrigation, canal proximity, deficient drainage and waterlogging.

NAGINA.—An old town of 21,400 inhabitants, with a juvenile spleen rate of 79·1 *per cent.* in 1,957 children examined, it was found by Major J. C. Robertson, I.M.S., in 1909–1910 to be bounded on the east and north-east by a water-logged area, over practically all of which rice and sugarcane were cultivated, while these crops also flourished, though to a less extent, to the south-west and north. These rice and cane fields, together with two rivers, a canal and numerous tanks, which are in immediate proximity, and some storm water overflows, all constituted a congeries of breeding grounds for the three proved carriers culicifacies, fuliginosus and maculipalpis, the areas under rice and cane being considered the most dangerous. Briefly Major Robertson's recommendations were—

(1) To abolish rice cultivation within half a mile of the site and substitute other crops.

(2) To attack the tanks by filling up some with town rubbish, and by fouling others.

(3) To stop irrigation within half a mile of the town and watch for increased damage from this source which is at present trivial.

(4) To close the canal gul to the railway station.

(5) To improve syphonage arrangements at the storm water overflows.

(The rivers were considered harmless owing to their distance.)

Map.—To make the project more easily intelligible I have had this map prepared on which all the salient points in the scheme are represented. In the centre, coloured in red, is the city site, while all the blue areas are tanks, the eastern boundary being the Pandhoi nadi, while the western is formed by the Karula nadi, the railway and the canal.

The works provided for in the estimate are in accordance with the recommendations of the committee, and the following resumē of these also shows how far they have been or are about to be carried out:—

Committee's resumē.	Action.
(1) *Rice.*—Rice cultivation should be absolutely prohibited within half a mile of the inhabited area. A summary enquiry as to the question of compensation should be made at once. Boundaries are laid down on the Assistant Engineer's map.	This is being done by the Collector.
(2) *Canals.*—No re-alignment of the canal is necessary, but the canal should be flushed weekly.	This will be carried out.
The gul No. 12 from the brick-fields to the railway should be closed at once.	Orders have been issued.
(3) *Tanks.*—Five methods of dealing, with these are advocated—	
(*a*) If small and earth is available, fill them up completely.	Tanks 2, 13, 21, 23 are being treated thus at a cost of Rs. 2,416.
(*b*) If above not possible fill to such a level as to enable them to be drained into the existing nadis, Pandhoi or Karula on west and east.	It is proposed to cut two drains—one to the north of the town (the north cut) and the other to the south of the town (the south cut)—and to drain from these either completely or partly a number of the largest tanks as well as some of the outlying tanks by means of small connecting drains. Tanks 4, 5, 7, 8, 9, 10, 11, go into the Pandhoi nadi by the north cut. Tanks, 14, 15, 16, 17, 18, 19, 20, go into the Pandhoi by the south cut. Patari B/1 and B/2 specially mentioned in the report as highly dangerous will be drained directly into the Pandhoi nadi by separate channels.
(*c*) Where it is not feasible to fill the tank to a level at which it can be drained, it is to be drained as low as possible and the area remaining is to be deepened in the centre and the material so obtained placed at the sides, so that the area of the tank will be reduced and it will have no shallow sloping banks.	No tanks are being so treated.
(*d*) Where it is not possible to drain at all, the tank should be deepened in the centre and the material placed at the sides.	Tank 3 is being so treated at a cost of Rs. 500.
(*e*) Where none of these are suitable if the tank lies to the south or south-east, it should be fouled with town rubbish.	No tank is being so treated.
	Tank 12 has been omitted, because of its distance and expense of filling it up being so great. Tanks 6, 22, 24, 25, 26 are not mentioned in the original report. (Engineer's remarks).
(4) *Excavations.*—All fresh excavations in the town and within one mile to be prohibited. If necessary, under the law, the Municipal limits should be extended accordingly, and the prohibition should extend to the existing brick-fields which are extensive near the railway line and Bijnor road.	The Collector and Sanitary Commissioner have been asked to see to this.
The Railway should fill up the tanks in the station yard.	
The Municipality should consider the advisability of acquiring the tanks to be filled in with a view to reselling them later on as cultivable land.	The cost of purchase of this reclaimed tank land has not been included in the estimate.
(5) Storm water overflow repairs.	Part of this cost (Rs. 1,360) has been included in the cost of the north cut the remainder will be done by the Municipality.

The north cut, owing to its proximity to the town, will be provided with a pucka section up to one furlong from its connection with the Pandhoi nadi so as to prevent irregularities forming in the bed and affording breeding places for mosquitoes and to enable the cut to be made on one continuous gradient of 8′ per mile and do away with the necessity for falls. The south cut will only have a pucka lining from tank No. 17 to its crossing with the Dhampur road as this is the reach nearest to the town boundary.

The estimate.—The total estimated cost of the project as outlined above, so far as the irrigation part is concerned, is, inclusive of establishment, tools and plant, about Rs. 79,579, and it will, I think, be admitted that this project when completed bids fair to give every chance to the recommendations made by the Special Malaria Officer.

SAHARANPUR.—This town of 66,254 inhabitants, showing a juvenile spleen rate of 78·8 per cent. in 2,665 children examined, and a malarial parasite infection rate of 53·8 per cent. was in 1909–10 reported by Major Robertson to be surrounded by a waterlogged area due to excessive canal irrigation. The Pandhoi and Dhamola nadis which join near it are continued in a channel formerly aligned and excavated, and into these the four main drains escape. Four canals, many large groves, and areas of tall grass, are in close proximity while rice and sugar cultivation abounds. Tanks are absent though four considerable pools are noted. The heaviest malarial intensity is on the south-west corner and the least is on the south-east. culicifacies, fuliginosus, listoni and maculipalpis mosquitoes were found to be carrying malaria, and were found in quantity. The rivers breed culicifacies and listoni, the storm drains and a waterlogged area in the south-west corner gave all the four, though the brick lined sewage-fed Underoni nala gave none, the tanks gave Culicifacies and fuliginosus, the rice and sugar fields gave culicifacies, fuliginosus and maculipalpis and the roadside drains culicifacies.

The Special Malaria Officer says "All the breeding grounds owe their origin to "the very extensive irrigation close to and to the west and north of the town-irriga- "tion which is beyond the natural drainage of the place".

Major Robertson's recommendations were briefly to—

(1) Substitute well for canal irrigation within one mile of the site and abolish rice and sugar cultivation within half a mile.

(2) Make the stream drains Karegi and Underoni pucka throughout if canal irrigation is not stopped; but if it is, then fill in the side branches of deeper central channels of the Karegi nala and alter the escape into it of the Shahpur minor by diversion into the Adampur drain if it is not required as a flush. If a flush were required the channel should be pucka for quarter mile from the edge of the town.

(3) Leave rivers alone as being too costly.

(4) Fill up tanks, except two in the Government gardens in which the fish "Millions" should be placed.

(5) Clean up grass and weeds on roadside drains, and level sides and bottoms: cut down, clear, and crop the grass and trees in groves and orchards.

(6) Treat specially five different drains as indicated in report.

The Committee met on the spot in May 1912, and a resumē of their recommendations and action proposed or taken is given herewith. A special map has been prepared—

Resumē.	Action proposed or taken.
(1) That canal irrigation be stopped within a three-fourth mile limit of the city edge, the defined area being bounded on the south by the railway up to Dhamola Bridge, on east by the Dhamola river, on west by a line from the Shahpur minor to mile 2 furlong ½ on the Megh Chappar distributary and on the north from a point miles 2 furlong 1½ from head of Shahpur minor to Dhamola river three-fourths mile north of Northern Dehra road.	This is for the Collector.
Sugar and high crops should be prohibited by Municipal bye-law and provision for such prohibition made at next settlement.	

Resumé.	Action proposed or taken.
(2) *Reduction of breeding grounds*—(*a*) *Tank F. K. J.*—Fill in F (Major Robertson's map E) and its extension K (all in railway limits) so as to drain through existing syphon into Dhamola, reconstruct training embankment where it is cut near railway bridge; straighten drain J and provide with falls to prevent flooding by cutting back.	Railway being addressed by the Sanitary Department.
(*b*) *Marsh M and tank E.*—Municipal ward to acquire area to be dealt with and adjoining brick kilns, fill in pits and shallows first, raise whole area to level of Karegi Nala bank. The area E should eventually provide building sites if levelled with the Chakrata Road.	Municipal.
Stop all excavations now proceeding in these vicinities.	
(*c*) Legislation by municipality is imperative, and no brick burning should be done within 1½ miles of the city.	Municipal.
(*d*) Adopt lift irrigation from wells for the Botanical gardens and stop canal water.	Municipal.
(*e*) *Karegi Nala.*—The most urgent of all the projects is the extension of the brick lining of this drain from the point D (Robertson's map) upwards for 6,000 feet to old aqueduct and if possible further east, and fill in the side breaches of the deeper channels.	This is estimated for at a cost of Rs. 34,737, of which Rs. 4,507 goes in a concrete bed.
(*f*) *Chilkhana road drain.*—Line with masonry and cunette the last 800 feet of this Nala from Raji Shah Kamal bridge to Pandhoi Nala and cunette the existing masonry portion above this for 2,500 feet while still further up it should be lined with masonry and cunetted as far as the Shahpur distributary.	This is estimated for at a cost of Rs. 9,539, of which Rs. 1,069 goes in a concrete bed.
(*g*) *River.*—It is highly desirable to complete and extend the masonry bed of the Pandhoi both downwards to the junction with the Dhamola and upwards to the north for at least 2,000 feet.	This is estimated for at a cost of Rs. 1 09,499, of which Rs. 11,504 goes in a concrete bed.
(*h*) Further make a masonry bed for Dhamola at its junction with the Pandhoi down to the railway bridge and extend this from the junction upwards to the Jail bridge (near Botanical garden). These are both costly but necessary if other action is not to be stultified.	The Dhamola portion will prove exceedingly costly and the canal Engineers doubt if the section from the junction to the railway is a serious breeding ground owing to the amount of sullage it contains from the town drains. The diversion of the Pandhoi into the Dhamola above the town is impracticable.
(*i*) *Undergrowth orchards, etc.*—The Board should apply section 106 of the Municipal Act which requires the clearance of noxious vegetation and see that drainage channels are kept free of weeds, grass, etc.	
(3) *General.*—If the above recommendations do not succeed in reducing the spring water level, then underdrain the whole area by a deep intercepting drain enclosing it in the west-north and north-east.	Municipal.
The committee calls special attention to the deplorable conditions prevailing in the Railway lines, the northern limit of which is within half a mile of the city.	
This though outside the scope of Major Robertson's enquiry provides condition most favourable to the spread of malaria and should also be attended to.	
Total estimate.—The total estimate of the irrigation department is Rs. 1,58,017 including establishment, but excluding the filling in of tanks either Railway or Municipal.	

Kosi.—With a decadent population of 7,003 whose juvenile members showed a spleen index of 81·3 per cent. in 964 children examined and 26 per cent. of the bloods with malarial parasites, Kosi was found by me in 1910, 1911 and 1912 to be suffering from a condition of water logging due to defective drainage and to proximity to the main Delhi Agra canal. Though the place was surrounded by tanks many of which were perennial the only species of mosquito found "carrying" was Culicifacies the chief and only important source of which was the main Agra Delhi Canal 300 yards away. Stephensi was found in a large number of partially used wells, but was never incriminated. That the canal was the "fons et origo" was further borne out by the fact that the town area immediately abutting on the canal, *i.e.*, to the west, showed evidences of more intense malaria than any other area did. Residual irrigation was not a factor in breeding ground causation; but this was closely bound up with the rainfall which, with the practically empty canal bed, inability of the Kosi branch drain to carry off the drainage of the town with sufficient rapidity through the syphon under the railway and main canal, and consequent stagnation, produced severe flooding and temporary breeding grounds with highly dangerous potentialities owing to the close proximity of the main canal, from which millions of carriers swarmed. The Kunds and large perennial accumulations showed a marked absence of larval life and the fouler they were the more noticeable was this.

The recommendations made by me in 1910–11 were briefly:—

(1) A further series of observations in 1911–12 into the mosquitoes, bloods, spleens and the rôle of stephensi, as the year of investigation had been unusually mild malarially.

(2) Anti-larval operations affecting the main canal, the wells, and other known breeding grounds.

(*a*) *Main Canal.*—Levelling, grading and cunetting the bottom opposite the town (mile $54\frac{1}{4}$ to 56) so as to ensure a 2 feet per sec. flow when the main canal was shut off; cleaning the grass edges; providing if possible a weekly flush during the rains when the canal is closed. If these are not entertained, then petrolage, cleaning and scooping of pools in canal bed, by a gang. (*Vide* map 3.)

(*b*) *Wells.*—Fill up disused wells, and screen 26 partially used wells, stocking with the local fish gerai (Ophiocephelus gachua) all the wells in which stephensi were found.

(*c*) *Known breeding grounds.*—Reduce these by more efficient drainage, by filling up certain excavations, draining others, and preventing fresh ones, and by gang petrolage efforts.

It was pointed out that unless more rapid and efficient storm water drainage was provided for the town drains, it would be a mistake to attempt to fill up the large tanks most of which were apparently doing little harm and were useful reservoirs for storm water.

(3) Try to reduce spring water-level by stopping irrigation from certain distributaries to the north-west of the town.

(4) Preserve the water weeds Lemna, Azolla and Wolffia.

(5) Issue of quinine free to the children in tablet form as a test for several years.

The Committee met at Kosi on the 12th May 1912 and a resumē of its recommendations and of action taken or proposed is appended. Two of the original report maps and a special project map are appended. (*Maps* 3, 4, 5.)

Resumē.	Action taken or proposed.
I.—Treatment of Canal.	
(*a*) Waterproof the canal bed for $2\frac{1}{2}$ miles in the immediate vicinity of Kosi (mile $53\frac{1}{2}$ to 56) by the Punjab system of cement slurry and cunette the bottom for two miles, the proposal to divert the main canal for four miles being hardly practical.	It is proposed to puddle the canal bed for two miles at a cost of Rs. 18,157 and to carefully observe the spring water-level before and after.
(*b*) Flush the canal at 8 day intervals during the period of closure.	This may not be required when the improvements proposed are carried out.

Resumé.	Action taken or proposed.
II.—Drainage.	
(1) *Kosi town area.*—By altering the position of a fall from mile 61 to 54·4 and so lowering the canal bed opposite the town to 604·25 the Kosi town drain could be re-adjusted to enter the canal at this point at a reduced level of 606 and so Kosi town could be drained in a few hours. The existing connection with the Kosi branch drain could remain and be used in the winter or dry months when the canal was running full and storm water was little.	The canal bed will be lowered for 5 miles and this is estimated to cost Rs. 32,287.
(2) *Kosi branch drain.*—Three alternatives are proposed—	
(*a*) Turn the Kosi branch drain into the main canal by a separate inlet, raise the present banks of the drain north of the town to prevent flooding, and preserve the existing syphon for extraordinary contingencies, inserting a cunette in the drain from the syphon to the Pitar Fund to minimise malarial risks.	This is not being carried out.
(*b*) Realign the Kosi branch drain and syphon it under the canal one mile north of the town by a new syphon. This necessitates one culvert, one rail crossing and two syphons. This is recommended if funds are sufficient, but if not then the former.	This drain will be diverted into the Kosi arterial drain at mile 2-6 on the drain and it will be necessary to carry it across the grand trunk road, railway, canal, and Sahar distributary by new syphon. The estimate for this is Rs. 24,848.
(*c*) Realign the Kosi branch drain so as to pass to the south-west of Kosi and be syphoned under the canal by a new syphon. This involves two railway crossings, two syphons, and one culvert. This is the most expensive and least satisfactory.	This is not being carried out.
III.—Tanks and depressions.	
Fill up all tanks and depressions except the Madri Kund to a level allowing of drainage into the Ganda Nala which should be regraded, lined with masonry and cunetted.	It is proposed to fill all hollows and tanks to a level of about 2 feet above bed of circular and Baldeogunj drains which will be provided with a masonry cunette. The estimate for tank filling is Rs. 29,648 and for regrading and relining the town drains is Rs. 32,127.
Railway borrow pits and excavations should be levelled up and drained for half mile north and south of the inhabited area by the railway authorities.	This is for the Railway Company.
IV.—Wells.	
Certain wells used mainly for domestic purposes (8, 17, 34, 37, 60) should be fitted with fixed iron tops and a hinged or sliding door and jug pumps, while into old agricultural wells (5, 28, 32, 48, 50) the fish Gerai (Ophiocephalus Gachua) should be introduced, and if the latter fails bi-weekly petrolege by the municipality should be introduced.	The canal project does not touch this. It is presumed it is municipal.
V.—Irrigation.	
No further restrictions are indicated.	
VI	
Government or the municipality should acquire all areas being filled up or raised and the municipal area should be extended to control further excavations.	

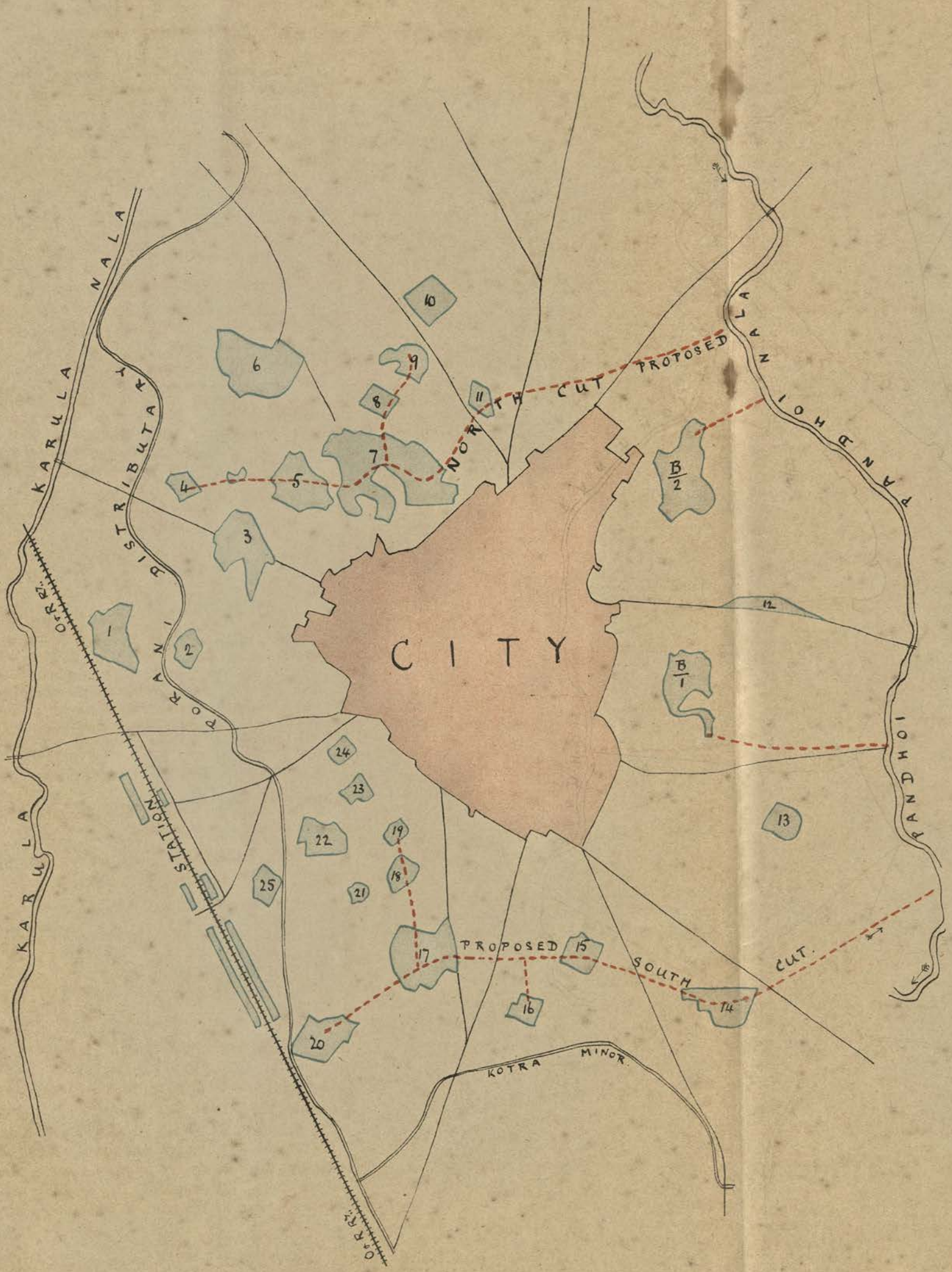
The total estimate for the different works including extra establishment is Rs. 1,44,317.

Nagina project estimate is Rs. 79,579, Saharanpur is Rs. 1,58,017 and Kosi Rs. 1,44,317 or a grand total of about Rs. 3,82,000. These estimates affect the Irrigation department only; but owing to the time necessary to collect materials, establishment, etc., this department is likely to spend between Rs. 60,000 and Rs. 70,000 on each of the three projects before the end of the present financial year.

NAGINA PROJECT.

MAP 1.

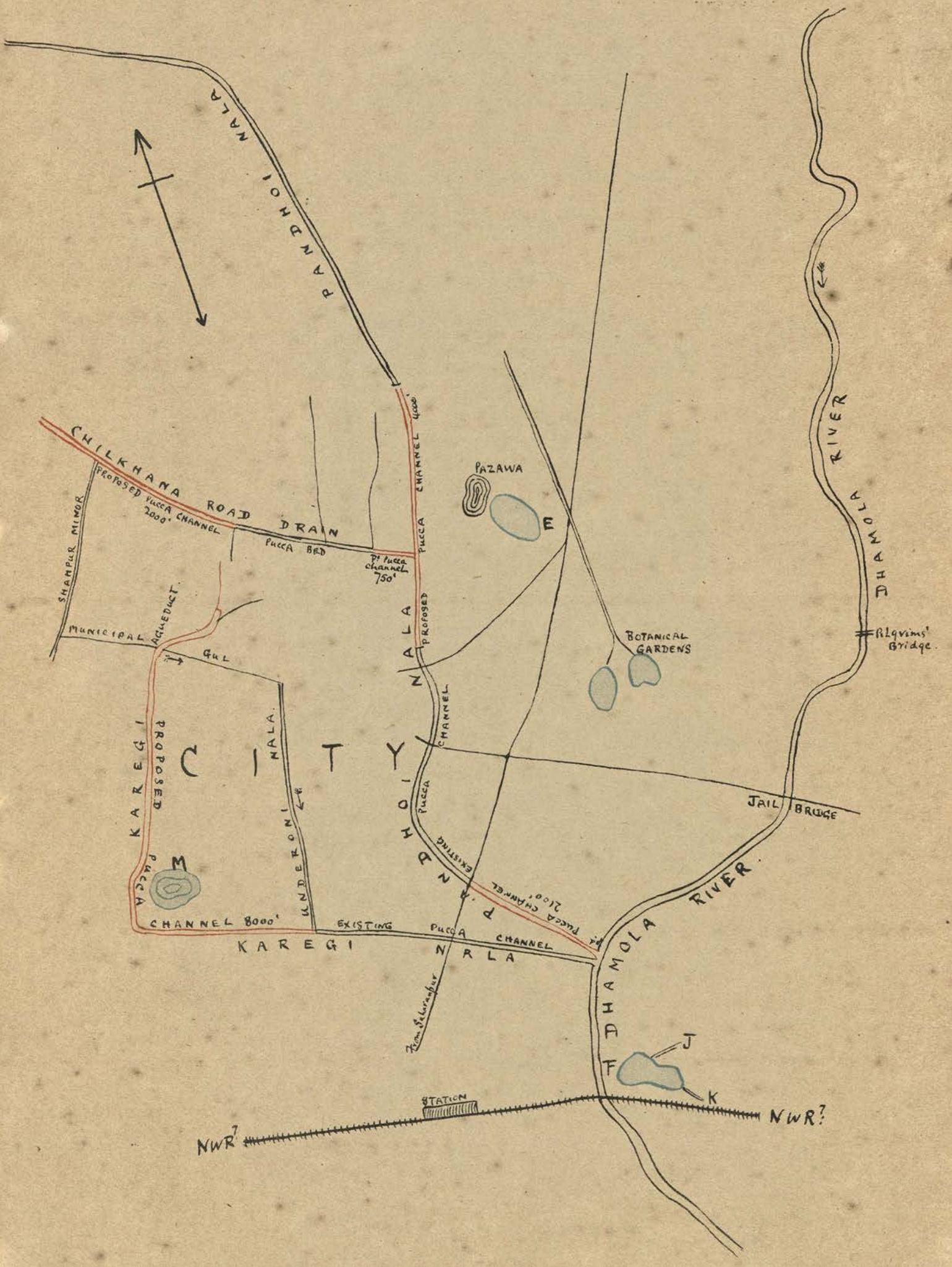
4 Inches = 1 Mile.



SAHARANPUR MALARIA PREVENTION SCHEME.

MAP 2.

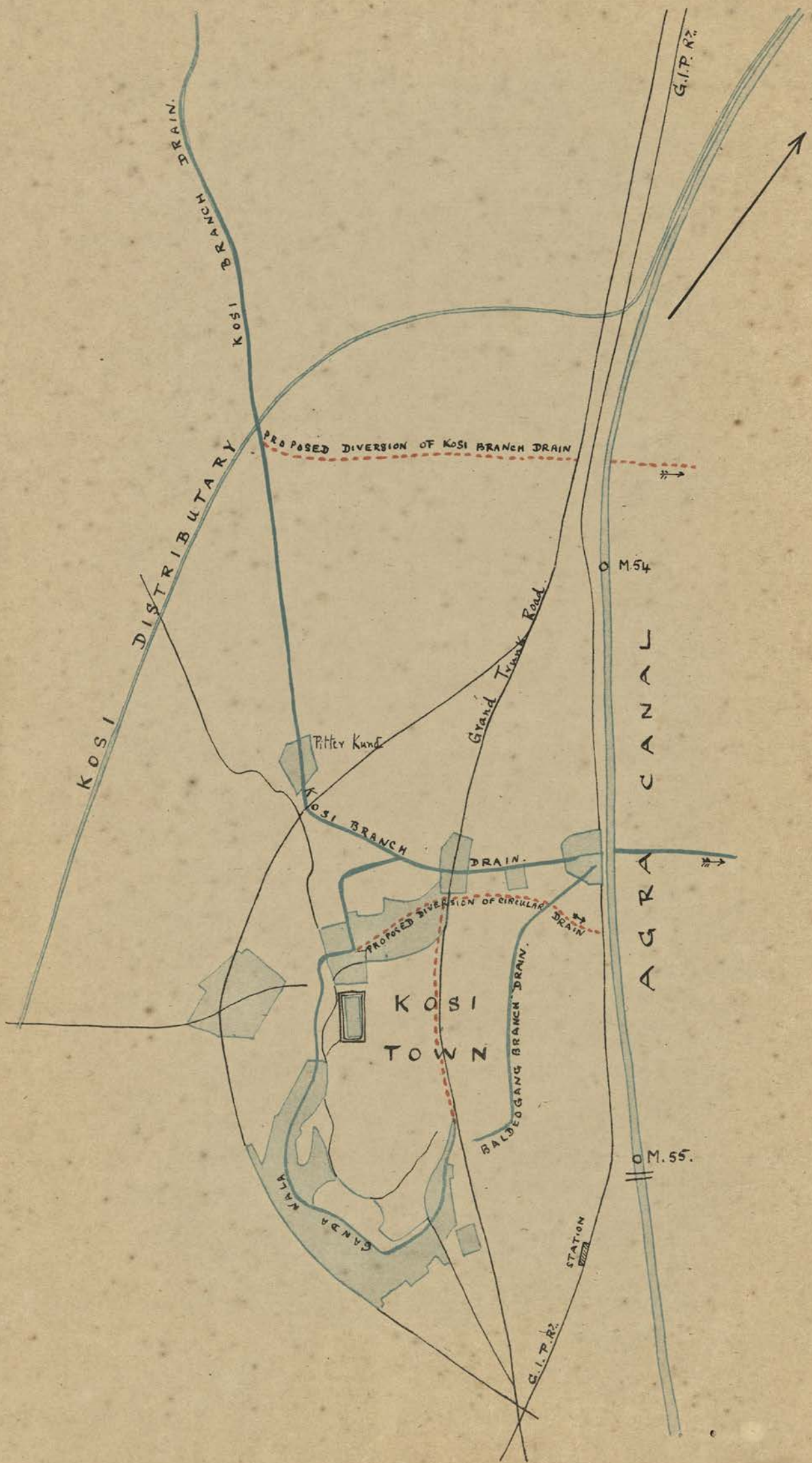
1 Inch = 2,000 Feet.



KOSI ANTIMALARIAL PROJECT.

MAP 3.

4 Inches = 1 Mile.



SOME NOTES ON LARVÆCIDES AND NATURAL ENEMIES OF MOSQUITOS IN SOUTHERN INDIA.

By H. C. Wilson, Esq., Piscicultural Expert to Government of Madras.

I think it is universally admitted that for the destruction of mosquito larvæ and pupæ there is no better natural enemy than fish, the other natural enemies of lesser value being found amongst aquatic insects and their larvæ, crustacea, molluscs, and larvæ of non-aquatic insects; the frog should be included as an enemy of the mosquito itself especially when this insect is egg laying or resting on the pupa before first flight.

Observations and experiments were made at the Government fish farm at Sunkesula, Kurnool district, over a considerable period; most of these tend to show that the mosquitos with their natural instinct for preservation when depositing their eggs, avoid as much as possible all waters where their natural enemies exist. So the wholesale stocking of waters with larvæ destroying fish will naturally tend to reduce the number of safe spawning grounds, and thus be of greatest value.

In one of the experimental ponds stocked with larvæcides I arranged the control pool at a corner isolated from the pond by a small bund which the fish could not pass. Both contain shallow water with water plants, and being sheltered by a big bund on one side and an overhanging tree on the other, it seemed to form an ideal breeding place for mosquitos. Although this has been under observation for some time, no larvæ have ever been found in the pond or the control. As this control is very small it might appear to be connected with the pond, and the mosquitos undoubtedly seeing their natural enemies in very close proximity, give it a wide berth and go to safer waters.

At another experimental pond I removed the control some 15 or 20 yards away, constructed it under a small tree, well protected from wind. The pond was stocked with a number of fish larvæcides and the result up to the present time shows that no mosquito eggs or larvæ have been found in this pond; but both eggs and larvæ have been found in the control.

Another experimental pond was constructed right out in an open space with no protection from the wind; it is kept entirely clear of fish and as far as possible other larvæcides. No mosquito eggs or larvæ have been found in this pond so far, which shows a tendency of this insect to avoid wind swept waters where sheltered ones can be obtained in the immediate neighbourhood.

Another experiment was carried out to try and determine if the mosquito when about to deposit her eggs could detect the absence or presence of its natural enemies. Six tubs were placed in a sheltered and dark shed with a open doorway; each tub contains water, floating grasses and waterweed. Numbers 1, 3 and 5 have no larvæcides; numbers 2, 4 and 6 each contain different species of larvæ destroying fish. These tubs were placed close together in a line and care was taken to see the water when put in contained no mosquito eggs or larvæ.

The fish experimented with were Chela argentia, Haplochilus affinis and Ambassis nama. The object of putting different fish larvæcides in each tub is on account of the habits of some enabling their presence to be detected easier than others.

Chela argentia.—These fish will suddenly appear in places where the eye could not see them before and with lightning rapidity take a larvæ or other food and again disappear. If a mosquito goes near the surface of the water when they are on the feed they will jump several inches above the surface to try and catch it.

Haplochilus affinis.—Often swims very near the surface of the water and may remain stationary there for some little time. If the surroundings are of similar colour their presence is difficult to detect excepting for the occipital spot.

Ambassis nama.—Is a very thin fish and is difficult to see when looking straight down on him in a tub.

This experiment which is still being carried on is of considerable interest; the results up to the present time have shown an absence of mosquito larvæ and floating eggs in all tubs.

The chief natural breeding grounds of mosquitos at Sunkesula are to be found in the numerous worn out hollows of rocks of the river bed (Tungabhadra). These hollows which are formed by the action of the water and stones are common to all river beds of a rocky formation. Some of these holes are of considerable depth and retain water for long periods; the gradual evaporation of this brings the water level below a dome-like edge of rock which protects the surface from the winds. Such favourable safe breeding grounds are taken full advantage of by the mosquitos, as I have found during most of my tours down river beds. One of these holes in a rock in the Tungabhadra which appeared favourable as a breeding place in every way, and being surrounded by others heavily stocked with larvæ of both Culex and Anopheles was found to contain a few very small fish of the genus Barbus and no mosquito larvæ or eggs. Only two conclusions could be drawn from this, *viz*:—

(1) that the mosquitos detecting the presence of their natural enemies avoided it;

(2) that the fish had disposed of all larvæ and eggs or eaten the mosquitos while egg laying.

I favour the former as the natural instinct of self preservation must come to the mosquito's assistance especially at such an important period (egg laying) in her career.

Experiments were carried out in natural ponds to try and determine the respective values of different mosquito larvæcides. One of the experiments was with the following fish, *viz.*, Chela argentia, C. Phulo, Haplochilus affinis, H. lineatus and Danio acquipinnatus and several small species of Barbus. The method adopted was to distribute mosquito larvæ round the margins of the pond occupied by the respective fish by means of glass dippers. After a short period the ponds were thoroughly examined and the margin netted for any remaining larvæ.

The final result of these tests was entirely in favour of the Chelas as far as rapidity of destruction goes. They cover large marginal water areas in a very short time in search of food. H. affinis and H. lineatus are good larvæ eaters but their movements are so slow compared to the lightning rapidity of the Chela that given equal numbers they would take a very much longer time to work the margins of a good sized pond.

The tests for respective values of the others were not so good, as they had been only transplanted a day or so previously.

The Chelas are remarkably active in the early mornings and evenings which means that they are thoroughly on the feed then. They can be seen feeding along the margins of the pond and rising to small insects on the water. During the middle of the day they seem to favour the deeper waters and become less active, occasional rises being seen in the centre or deep parts of the pool, but not feeding regularly. In distributing larvæ to the Chela pond when they are on the feed, the fish can easily be seen like a silver streak as they take them off the surface and while wriggling just below.

I notice in Messrs. Sewell and Chaudhuri's pamphlet "Indian fish of proved utility as mosquito destroyers" that they quote "Bentley" as stating the value of the "Chelas" has been exaggerated and that they will leave larvæ untouched for long periods. The only possible explanation I can offer is that the larvæ have been put in a pond at a time when the Chelas were not on the feed. Tho above-mentioned authors state (page 18) that "None of the members of this genus are surface feeders and we have found them of little or no use in destroying larvæ." There must be some mistake here as all the members of

this genus are surface feeders and amongst our most active ones; the upward position of their mouth clearly shows where they feed.

A similar error has been made on the same page with reference to Rasbora daniconius where it is stated that it is purely a vegetable feeder; this is not so as it takes small flies off the surface of the water and can be caught with a small artificial gnat.

An experiment was made with "Therapon jarbua" which is common in all backwaters; four of these were placed in a tank with 50 mosquito larvæ; after three hours a careful search was made and only four larvæ were found. Another lot of mosquito larvæ numbering upwards of 300 were put in this tank one evening about 4 P. M. and the next morning the water was completely baled out and not a single larvæ was found.

The next experiment was with the small Nuria malabarica. Seven were placed in a glass tank together with mosquito larvae and at the end of four days they had not touched the larvæ.

An experiment was made with the pond skater (Gerris) which is a well known aquatic insect and widely distributed and can seize and hold living prey. I fastened a mosquito on to a minute hook with very fine gut and with the top piece of my fishing rod I danced this about on the surface of the water where several pond skaters were; they dashed at it and one secured it and went of. I raised the gut line and he did not leave go until I put him on dry land. Whether he is able to catch a mosquito in nature I cannot say for certain, but I should think highly probably, especially when the mosquito is egg laying or stretching its wings on its pupa raft preparatory to flying.

As the big pond skaters seemed to take fright at my operations, I went to a place where a number of young ones were sporting, and distributed mosquito larvæ. They struck at the larvæ whenever they came to the surface, but without catching them, as I observed the larva dashed away in each case. This striking game was carried on repeatedly but they never caught one while I was there.

A full grown Gerris kept in captivity in a small glass jar together with larvae and some small flies refused to touch anything and died in about six days.

I kept some small water boatmen Notonecta glauca in the same vessel as mosquito larvæ; after six days they had not touched the larvæ.

There is a small water flea (a crustacean) which I have often seen attack the eggs of a small fly like a Yellow Dun (Ephemiridæ) which swarms on the Kurnool-Cuddapah Canal and most rivers on the plains. This fly appears just after sunset and deposits its eggs on the water. While keeping these eggs under observation some years ago, I noticed this water flea attack and attach itself to an egg, the fertility of which it would not doubt destroy. There is no reason why it should not attack mosquito eggs; but this can easily be tested. The only use it could be put to would be in the small holes in rocks and puddles; I think, however, that these places are easily dealt with by using oil.

With molluscs I had similar experience and concluded that the unnatural surroundings make some of these tests untrustworthy.

I tried experiments on frogs in natural surroundings; I fished with a mosquito similar to the operations of the Gerris, dancing it about near the frogs. They seize it at once and could quite easily be hooked. In nature they will have difficulty in catching mosquitos excepting the periods as mentioned in the case of the pond skater.

During my tours in Southern India for the past six years I have often been told at small villages that if they take water from a particular well it is supposed to give them fever, but the other well which most of the people use does not. They also state that the presence of frogs in a well shows that the water is good, and the bad well seldom has frogs. An explanation of this may possibly be as follows:—The bad well may contain murrel (Ophiocephalidæ) a natural enemy of the frog, which would keep it clear of frogs and small fish. The presence of frogs

in the good well shows there are no murrel and it is highly probable that some small larvæ eating fish will be there also. The mosquitos would naturally favour the so-called bad well as it is the safest breeding ground, and multiply rapidly. It would be reasonable to suppose that a number of these will become infected with malaria germs by biting visitors to the well and so spread it. The fever is then put down to drinking the water of this well.

If it is ever dicided to treat all mosquito infested non-permanent waters suitable for fish by stocking with fish larvæcides each year, it will require a very large number. The best way to deal with this question from a pisciculturist's point of view is to establish proper breeding places at convenient centres where there is permanent water and from these centres transplant to the mosquito infested areas. It is certainly not policy to take them from the natural supplies of one district to stock another each year.

The natural distribution of these small fish that prey on mosquito larvæ in India is widespread, but it must be remembered that most of them that enter non-permanent waters each year, are killed when all these vast areas dry up.

I would suggest that a few of the well known larvæcides (fish) be selected and bred on a large scale at such centres as mentioned above. This is being done now at Sunkesula fish farm which will be able to supply Kurnool and the villages in the district, if Government request it. When the Sunkesula fish farm was constructed I stocked all ponds with Chelas before any other fish were introduced, for the purpose of keeping down mosquito larvæ; this was two years ago and they have kept my ponds entirely clear.

In conclusion I give the following particulars of fish I consider would be of most use in the different classes of waters to be stocked.

1. *Genus.*—Chela (all species are useful but the smaller ones are the best).

   Geographical distribution of genus according to Day: Sind, Continent of India and Burma including Malay Archipelago.

   Class of waters where these species would be of greatest service: tanks, swamps and village ponds.

   The members of this genus are not good travellers, but if taken in properly constructed carriers can travel considerable distances safely.

2. *Genus Haplochilus.*—Day gives four species.

   Geographical distribution of the genus: India, Malay Archipelago and beyond, tropical Africa, Islands in the Indian Ocean, also temperate and tropical America.

   Best suited for stocking wells, channels, stagnant pools, and any mosquito infested waters at long distances from the breeding grounds.

   These fish are exceedingly good travellers and if properly prepared for a journey (conditioned) and not overcrowded can be kept in the same water for days together, the water requiring very little æration.

3. *Genus-Therapon.*—Species Therapon Jarbua.

   Geographical distribution of the species (Day): From the Red Sea and east coast of Africa through the seas and estuaries of India to Malay Archipelago and north coast of Australia.

   These are suitable to stock backwaters, salt and brackish swamps and pools near the coast. These fish can also be used in fresh water ponds.

   They travel fairly well, if care is taken.

A STEGOMYIA SURVEY OF THE CITY AND ISLAND OF BOMBAY.

By Major W. Glen Liston, M.D., D.P.H., I.M.S., and Sub-Assistant Surgeon T. G. Akula.

Bombay City, the capital of the Presidency and the principal sea-port of Western India, is situated on an island in 18°55′ N. and 72°54′ E. The island is for the most part flat, is some 11 miles long by 2 or 3 broad. The distribution of the population over the island is irregular, the greatest concentration being found in the south, while the northern portion is sparsely populated. Large docks extend along the greater part of the eastern shores. During the year 897 vessels of 2,358,893 tons burden engaged in foreign trade entered the harbour. The bulk of the imports are supplied by the United Kingdom, but there is considerable trade between Bombay and the Far East.

The climate of Bombay throughout the year is strikingly uniform, there are no extremes of heat and cold. The climate may be said to be temperate, but is oppressive owing to extreme saturation of the air with moisture during the greater part of the year. The cold season is short, lasting from December to March. The hottest months are May and October. The average rainfall is about 80 inches, though there is a considerable variation from year to year with a minimum of about 35 inches and a maximum a little over 100 inches. The rainfall is almost wholly confined to the monsoon months June to September.

The *Culicinæ* survey of the island was begun in the end of July and the present review covers the period August and September. The work was undertaken by the authors in co-operation with the Municipal and Port Trust Officers. We take this opportunity to thank Dr. Turner, Dr. Shroff, and Mr. Lythe for their co-operation with us.

The larvæ of mosquitos of the sub-family *Culicinæ* have been collected and identified from 922 breeding places where they were found. As will be seen from the accompanying table about 51 per cent. of these mosquitos belonged to the genus *Stegomyia* and the allied genera *Scutomyia* and *Dosvoidea*. The species identified belonging to these genera were *Stegomyia fasciata* and *scutellaris*, *Scutomyia sugens* or a species closely related thereto, and *Desvoidea obturbans*. By far the most common mosquito of this group was *Stegomyia fasciata*. Its breeding places were found 273 times. The proportion of these mosquitos to others of this group was 59 per cent. or about 30 per cent. of all *Culicinæ* found in the city. The breeding places of this mosquito were distributed all over the island, in the most densely populated part of the city as well as in the more open country or suburbs. *Stegomyia fasciata* showed special preference for certain kinds of breeding places being found 106 times in wooden tubs containing water, so that this type of breeding place constituted 39 per cent. of the whole. Other selected breeding places and their relative proportion to the whole were cisterns 11 per cent, iron vessels, tin pots, etc., 9 per cent, wells 8 per cent., wooden barrels 8 per cent., cattle troughs 4 per cent., masonry, garden tanks, cess-pits, zinc baskets 3 per cent. The larvæ of *Stegomyia fasciata* were more rarely found in the following situations broken pots, cups, lily-pots, fire buckets, earthen drinking pots, hollows in iron girders and other odd receptacles as shells or antiformicas. In every instance the breeding places were found in what may be called artificial collections of water associated with human habitations. The water in almost every case was clean and free from putrifying material, in this respect this mosquito differs from those described below.

The larvæ of *Stegomyia scutellaris* were found on 56 occasions. This species of mosquito constituted 12 per cent. of the *Stegomyia* group and 6 per cent. of all *Culicinæ* met with. It was not found, like *Stegomyia fasciata*, evenly distributed over the island, but was met with in the urban parts only where the houses were surrounded by gardens and where shade and shelter were available. This mosquito was more commonly found in the suburbs of the city. Like *Stegomyia fasciata* its favourite breeding places were wooden tubs and iron pots; such breeding places constituted about 48 per cent. of the whole. As

compared with *Stegomyia fasciata* this mosquito exhibited rather a preference for iron vessels. Less frequent breeding places of the *Stegomyia scutellaris* were wells, cattle troughs, and occasionally the larvæ were found in such places as broken bottles, cups, flower pots, fire buckets and antiformicas. It was rarely though occasionally found in pools and ditches filled with rain water.

Scutomyia sugens, or a species closely related to this mosquito, was met with in different parts of the island, especially in the neighbourhood of the new docks. The breeding places of this mosquito constituted 22·5 per cent. of the whole of the *Stegomyia* group.

The breeding places of *Desvoidea obturbans* were found on 29 occasions forming thus 6·2 per cent. of the *Stegomyia* group. This mosquito was generally found breeding in dirty water coloured brown by organic matter in solution. The larvæ are most commonly found in drains which are often connected with stables. They have also been found in wooden tubs and hollows containing rain water, in iron girders and in disused machinery. More rarely they have been found in cattle troughs, masonry tanks, fountains, buckets, cess-pits and roof gutters.

Of the other *Culicinæ* encountered in our survey *Culex concolor* and *fatigans* were the most commonly found. *Taeneorhynchus perturbans* was also occasionally met with. On one occasion we collected some larvæ of *Culex mimeticus* and we also found a mosquito of unknown genus; unfortunately the specimens of this mosquito were so much damaged as to make it impossible to describe or identify them.

It has been clearly established that *Stegomyia fasciata* is widely distributed in the Island of Bombay. It breeds in places closely associated with human habitations where water has been accumulated for domestic use or where it has collected in disused utensils during rain. The climate and trade relations of the port of Bombay are such as to favour the spread of Yellow Fever should the Ports of the Far East become infected with the disease on the opening of the Panama Canal.

The breeding places of Culicinæ found in the City and Island of Bombay.

Species.	Number of places in which larvæ were found.
Stegomyia fasciata	273
Stegomyia scutellaris	56
Scutomyia sugens	104
Desvoidea obturbans	29
Culex concolor	249
Culex fatigans	197
Taeneorhynchus perturbans	13
Culex mimeticus	1
Total breeding places examined	922

STEGOMYIA IN KARACHI.

By Dr. K. S. Mhaskar, M.D., D.P.H.D. & H., on special duty Stegomyia inquiry, Karachi.

Karachi—the capital and chief city of the province of Sind—is situated on the northern shores of the Arabian Sea in 24′—47′N. Lat. and 66′—58′E. Long. It is the third in importance of the sea-ports of British India and is the natural outlet of the trade for Sind and the Punjab. It is the sea-board terminus of the great railway system of the North-West, which extends to Peshawar in the North and to Delhi on the East. The present importance of the port is due to its being the most westerly in India being 200 miles nearer to Aden than Bombay, and it may in future become the point of junction of a main line of railway to Europe.

Physical Aspects.—The area within Municipal limits comprises nearly 74 square miles and includes large areas of dry waste lands and useless rocky ground covered at certain seasons by water. The aspect of the surrounding district is hilly excepting that bordering on the sea. Ranges of hills, lofty and barren, run from north to south with deep wide valleys between. After heavy falls of rain these afford good pasturage. The populated area of Karachi town is much more limited being only 5 square miles and is in the shape of a triangle with its apex at the Custom house and the base formed by a line from the Cantonment Station to the Government Gardens. On the north and west there extends a shallow break-water through which runs the one river "The Lyaree" and a number of creeks connected with it. When heavy rains fall in the hills the river comes down in flood, but this occurs only for a few days of the year and generally the river bed is dry. The creeks are fringed with mangrove bushes and drain the marshy ground and mud flats which are covered with water at high tide. The tidal waters of the creek have a scouring effect and the mangrove swamps are almost entirely submerged twice a day.

Hydrography.—The canals of this district are all in the Indus delta which extends from Ghizri to Ghar 125 miles distant. The supply of water to the city is obtained from two wells on the Malir river 16 miles away and is from thence conducted by conduits into a distributing reservoir. The tanks in the city are all filled up. There are very few wells in the city, none being found in the Civil Lines nor in Kiamari which is the harbour proper. The *water-supply excluding that for garden and municipal use is 14·5 gallons per head per day.*

The town is not much above the mean sea level, the greater part of it being from 5 to 7 feet above that level while the Civil Lines are from 10 feet to 30 feet and upwards. Still the influence of the tides is felt in low-lying lands where the water oozes up at spring tides and forms shallow pools.

Drainage.—The town is partly drained on Shone's ejector system and gravitating drains. But the greater part is supplied with cess-pits from which the foul water is carted away. There are no storm water drains or entrances, and no catch pits.

Vegetation.—The vegetation is characteristic of a rainless climate, a dry atmosphere and a sandy soil impregnated with salts. Only the Babul and the Milkbush are seen and there are no jungles round about.

Climate.—The climate of Karachi resembles that of Bombay in temperature, humidity and equability, January being the coldest month and May and June the warmest. The months from April to October for five years show a mean maximum temperature of 89° F. and the months from November to March a mean maximum of 75° F. The average of the lowest recorded temperature for the same period of five years is 65° F.

Rainfall.—The rainfall is slight and precarious and is not confined to the usual monsoon season of Bombay, *viz.*, from June to October, but often happens in December and January. Nor is it ever a one long downpour.

Excluding the last two abnormal years the average annual rainfall is from 5 to 7 inches. The total number of rainy days during a year vary from 5 to 9. Still the volume of water brought down by the rivers from the hills rushes into the town and remains for a fortnight after in pools till it dries.

Humidity.—The atmosphere is moist. The lowest relative humidity occurs in December, *viz.*, 50. It begins to rise from January to April, reaching its highest 84 in May or June. The south-west winds prevail during 8 months of the year, and this added to the low situation of the town and stagnant pools in the break-waters that surround it, make the climate humid and moist. For the other 4 months the northerly winds prevail. The roads from the town lead straight from the harbour and there are also very large open areas; the houses are mostly two-floored. All these combine to make the wind acutely felt in almost all parts of the town.

Population.—The population of Karachi, according to census of 1911, is 159,270 and only 18,375 belong to the Cantonment and the harbour. The very large population is concentrated almost wholly in the old town.

The present survey started on the 27th of August deals with the Civil Lines, *i. e.*, the greater part at the base of the triangle explained above, the Kiamari harbour and village and part of Manora,—an island just opposite occupied by the Military, Port Trust and the harbour works. There were no rains during the period.

Breeding Places.—A detailed consideration of the breeding places met with indicates that the vast majority of them are artificial and differ with the class of people residing in the locality.

Civil Lines.—In the European quarter, *i. e.*, the Civil Lines, masonry tanks, mud or brickwork channels from these to various parts of the garden and cess-pits are most important. Next to these are the antiformicas—shallow vessels containing water placed under tables, etc., to prevent ants from ascending. Last of all are the drinking water chatties. There are no wells, no tanks, and no municipal drains. There is just beyond an extensive area of marshy land which is sparsely covered with low bushes and weeds and shows thick incrustations of salt on the surface. The water oozes up here and stagnates and the puddles, which are shaded by weeds or mosses, harbour hundreds of larvæ.

Kiamari.—The railway occupies a good deal of space on Kiamari and in connection with these there are a number of offices and warehouses. Only a small part is occupied by a village built on model lines by the Port Trust. There are no docks, but a long line of wharves extends from one end to the other. A few garden tanks, stand-pipes and drains from these and a few tubs not more than 50 all told, are the possible breeding places at the present time. In the village the breeding places are limited to the earthenpots for storing water, cess-pits and a few stand-pipes and cattle troughs.

Manora.—Manora differs from Kiamari and the Civil Lines. There are here half a dozen wells about twelve feet deep and containing not more than a foot of brackish water. Half a dozen tanks about 50 feet in diameter hold the telegraph cables and though cleaned every eight days were still found to harbour larvæ. The water-supply is limited; it is brought from across the harbour in large tanks and stored in smaller ones with mosquito proof lids. There are no gardens and most of the cess-pits were clean. The servants' quarters were found frequently infected as at Kiamari.

Varieties of Mosquitos.—The different species of mosquitos met with so far are: Culicines:—

Stegomyia fasciata,
Culex fatigans,
Culex concolor,
Tæniorhynchus (sp. ?)

Anophelines:—

Nyssomyzomyia rossi,

Neocellia stephensi,

Cellia pulcherima ;

and one more not yet determined, which may be *Nyssomyzomyia* or *Neomyzomiya.*

No *Desvoidea* were discovered.

By far the commonest is *Culex fatigans* which was found everywhere. *Stegomyia fasciata,* the only species of this genus found, came next in extent of distribution. These predominated at the harbour, and at Manora. The *Stegomyia* was seen flying about in workshops and offices in numbers. Since the commencement of the inquiry over 3,000 collections of water have been examined for larvæ, and include about 500 masonry tanks in gardens and compounds, about a thousand tubs, drinking water chatties and antiformicas, and about 20 private fountains and cattle-troughs and the rest of them cess-pits and drains, etc. The soil being porous, water easily percolates through and dries. There had been no rain during the period and so such likely places as tubs, disused troughs, tinpots and holes in machinery in the harbour, were dry.

In the Civil Lines ten per cent. of the breeding places had larvæ. The two anophelines were always found in the garden tanks and the channels leading from them. In these places there was little or no movement of water; they were shaded by trees, contained fallen debris and had muddy bottoms and slimy, or moss and algæ covered walls. The water when sampled in bottles was not much discoloured. Sometimes the two varieties were found breeding in the same place.

The *Culex* were limited to foul and stinking water in cess-pits or gardens or tubs in which manure was kept.

The Stegomyia fasciata.—The *Stegomyia fasciata,* is pre-eminently a chatty breeding mosquito here, even clean and new chatties with clean water being sometimes found full of them. Perhaps it is the odour of moist baked earth that attracts them most. They were never found in foul and stinking cess-pits like the *Culex fatigans,* but neglected cess-pits in which the water at one time might have been fairly clean showed them in numbers. A few clumps of bamboo were found in a few gardens, but no *Stegomyia* were found in these situations. Indeed, rarely was it found in the garden outside.

At the Kiamari harbour while the *Stegomyia* were almost always found in the drinking water chatties, the *culex* were found outside in the cess-pits in almost 50 per cent. of them. Only half a dozen places having gardens showed *Rossi* and *Stephensi.*

At Manora though the *stegomyia* has been seen flying about, its breeding places have not yet been discovered. The wells and tanks were full of the undiagnosed anopheline and *rossi.* The water in the wells was very brackish and the tanks hold sea water for the cables.

The method of investigation was to examine all the possible collections of water for larvæ and hatch them out in the laboratory. In most of the places where complaints were made of the prevalence of mosquitos an attempt was made to catch them in the bed rooms and out-houses, but only the *Culex fatigans* and *Stegomyia* were so caught.

The *stegomyia* bite viciously during the day and are not scared by light. Dark clothing attracts them most. It is essentially a domestic mosquito living and breeding in the immediate neighbourhood of houses and adapts itself to all sorts of conditions, provided that the water is stagnant. The larvæ are of creamy white colour and darken later to a pale brown tinge when they are about to change into pupæ. The intestinal canal can always be

made out with the naked eye as a dark line in the body. Their movements are sluggish and wriggling and they pass a greater part of their time browsing at the bottom. At the surface they hang limp down almost vertical or go round and round the receptacle with worm-like movements and probably feed on the surface film. Some of those which were smallest, when caught at the beginning are still larvæ, *i.e.*, they are at least 4 weeks old.

The pupa is not so dark as that of *culex fatigans*. The respiratory siphon tubes are not so long as in the latter and extend beyond the dorsum only by a fraction of their length. They are broader and the opening is slit-like and narrow. Within three days the imago hatches out.

The imago varies in size from 2·5 to 5 mm. the smaller size predominating. Their colour for a day or two after emergence is bright yellowish red on the thorax with white lines, it gradually darkens though never so much as seen in Bombay.

Culex fatigans, the larvæ are found in enormous numbers in the cess-pits especially at Kiamari. It breeds readily in foul water and stinking decomposing moss and fæcal contamination are no debar.

The brackish puddles in the marshes and mangrove-swamps showed species of *Tæniorhynchus* and *Anopheline*.

The *Nyssomyzomyia rossi* was found in large numbers in the brackish wells at Manora and in the salt water tanks.

Culex concolor was met with in a dozen places along with *Culex fatigans*.

Cellia pulcherima was found only once.

Besides the *culicidæ*, the sand-fly *Phlebotomus* was found everywhere and is a great pest at Manora.

The conditions under which the *stegomyia* are met with, so far, are all artificial and are probably not influenced much by rainfall, etc. Their finding is an index of negligence and carelessness.

In conclusion it is yet too early to consider the conditions which may influence the number of these mosquitos and their breeding places and the steps necessary to control them. Though only ten per cent. of the places are infected the nature of the rest is such that any one of the 90 per cent. may become at any time a potential nuisance.

PROGRESS REPORT—STEGOMYIA SURVEY—PORT OF CALCUTTA.

Major A. C. MacGilchrist, I.M.S., on special duty.

Only two species of *Stegomyia* (*fasciata* and *scutellaris*) have been met with in the Port of Calcutta. It is noteworthy that *S. fasciata* is found only in densely-populated areas. For this reason the term "domestic" as applied to it is not quite appropriate; it is too wide a term. *S. fasciata* is a town or city mosquito; it is not content to live in small villages such as occur on the banks of the Hooghly. In the Port of Calcutta this mosquito has been found only in the densely-populated parts of Calcutta and Howrah and in a small area in Garden Reach. See map. In Calcutta it is a very common mosquito in the northern part of the city—*i.e.*, north of Dhurumtollah Street, including not merely the Indian residential quarter but also the European commercial quarter and Government Secretariat buildings. By Paiva it has been found common also in the "fringe area" of Calcutta and especially in that part of the "fringe area" adjoining the northern part of the city—*i.e.*, east of Upper Circular Road. We have been unable to find *S. fasciata* in any of the villages on the banks of the Hooghly below Garden Reach.

S. scutellaris is exceedingly common throughout the port: it has no objection to either rural or city life. It does not object to live near a solitary isolated hut, so long as that hut is inhabited. While *S. fasciata* is seldom found breeding more than a few yards away from inhabited houses, *S. scutellaris* is often found breeding some 100 yards away. If, in Calcutta, a mosquito is found biting in the day-time, it is almost sure to be one of these two species. The only other species of mosquitoes which we have found to bite in the day are those of *Desvoidya*: they have been observed to bite occasionally in the late morning and early evening. The above *stegomyiæ* bite readily and frequently even in the middle of the day, their bite being more irritating and the result more conspicuous than those of other genera.

Only in rare instances have *S. fasciata* and *S. scutellaris* been found in the same receptacle and at first it was thought they might be antagonistic to each other. Their larvæ, however, when placed together seem to live quite peaceably: the adults emerge side by side.

Favourite breeding places for both species of *stegomyia* are the broken earthen pots, containing rain-water, which are found so commonly around houses.

S. fasciata has been found on the third floor of a house in the northern part of Calcutta in a very congested area. The larvæ are found whenever water can collect inside and in the immediate vicinity of dwelling houses. This species of *stegomyia* seems to prefer small collections of water; the eggs can resist drying for months. The larvæ have been found in receptacles holding only a couple of drachms of water which would all evaporate in a very few days. The following breeding places have been noted:—

1. Earthen pots of all shapes and sizes. (This is the commonest.)
2. Cement and masonry work (next commonest)—
   (*a*) water cisterns about 4′ square,
   (*b*) ornamental structures, *e.g.*, in Dalhousie square gardens for holding flower pots.
3. Metallic vessels—
   (*a*) galvanised iron cistern, 4′×4′×5′,
   (*b*) old tin box, 2½′×1½′×1′,
   (*c*) condensed milk tins — hung up as traps,
   (*d*) kerosine tins,
   (*e*) iron girder placed on its side, water being retained between the flanges.
4. Household utensils—
   (*a*) Enamelled iron bowl,
   (*b*) Porcelain flower pot.

It is odd that we have not discovered *S. fasciata* breeding in wooden receptacles possibly owing to such receptacles not being in very common use in Calcutta for holding water. *S. scutellaris* seems to prefer wooden receptacles next to earthenpots: it was found in—

(*a*) wooden tube,
(*b*) a hole cut in a log of wood, about 2″ square,
(*c*) hollows of bamboo stumps,
(*d*) a cocoanut shell,

The larvæ of *S. fasciata* and *S. scutellaris* were found together in an enamelled iron bowl.

We have not discovered the larvæ of *S. faciata* (or of *S. scutellaris*) in any very large collection of water of a tank or open drain, although Paiva apparently had found them in both of these places—during his survey of the "fringe area" of Calcutta.

While the larvæ of *S. fasciata* have been found only in receptacles made by man, *i.e.*, artificial, the larvæ of *S. scutellaris* are often discovered in natural receptacles such as hollows in the trunks of trees.

Both species of *Stegomyia* seem to prefer water coloured brown from the presence of decaying vegetable matter; the larvæ are never found in foul-smelling or brackish water.

Both species lay their eggs singly either on the surface of the water or on the sides of the vessel. The eggs of *S. scutellatis* are only about two-thirds the size of the eggs of *S. fasciata*. Some eggs of *S. fasciata* were dried and kept on blotting paper in an almirah for a month (October—November). When after that period the eggs were placed in water, larvæ made their appearance in less than forty-eight hours.

The larvæ of both species can remain quite a long time under water without coming to the surface to breathe. At the surface they hang almost perpendicularly. They are very sensitive; if in the least disturbed they go to hide at the bottom. They live mainly on vegetable matter; in the absence of vegetable matter they will feed on dead larvæ.

The larvæ stage lasts for seven or eight days. The differences between the larvæ of *S. fasciata* and *S. scutellaris* are minute; these two species can be differentiated only by the aid of the microscope.

The pupal stage lasts two or three days.

The adults of the species *fasciata* vary much in size and to a slight extent in shade of colour; those of *scutellaris* vary also greatly in size. The females of both species are generally larger than the males.

Under ordinary circumstances, these two species seem to bite only in the daytime and are most active in the afternoon from about 4 P.M. till it is quite dark. If kept caged all day and fasting; they bite at night, even mid-night, if they get an opportunity. Under ordinary or usual natural conditions, none have been caught biting at night.

The males of both these species frequently rest on the human body; so we tried several times to get them to bite but without success. Apparently the males, when they sit on the human body, are merely in attendance upon the females: they do not suck blood.

The bite of either species is very irritating and is followed in a short time by itching and swelling of the part bitten. Both species are very bold and persistent in their endeavours to bite.

Dark colours attract them; black clothes, umbrellas, etc., are favourite resting places.

Even on the first day of their life each species has been seen copulating. Under ordinary conditions they copulate on the wing: in captivity, after uniting in mid-air they rest on the wall of the cage, the female clinging to the cage and the male underneath the female and clinging to her ventral surface—*i.e.*, ventral surface to ventral surface. We have been unable to get any eggs from either species kept alive or days on fruit juice—although copulation occurs—so long as the females do not get a feed of blood.

It was observed that individuals of the species *fasciata* not infrequently copulated with individuals of the species *scutellaris*; but this coupling seems to be unproductive.

Both species of *stegomyia* are most numerous during the rains—as one would expect—inasmuch as the breeding places are much more numerous, *e.g.*, broken earthen pots will contain rain water. Eggs of *S. fasciata*, which may have been left dry after evaporation of the water months before, floating once more in water are now hatched out.

Why should *S. fasciata* be so much commoner in the northern part of Calcutta?

(1) Differences in storing drinking water: cisterns without lids: soda water: denser population: therefore more numerous water utensils.

(2) Population: denser population: therefore more blood available.

(3) Earthen pots and handis and other receptacles much commoner than in European quarters.

(4) Houses old: drainage bad.

The species *Desvoidya obturbans* is very common in the Kidderpore Docks and elsewhere. It breeds in foul stagnant water. It bites to some extent in the day time.

Leucomyia gelida was very common in Calcutta and neighbourhood during August and September: it breeds readily in earthen pots.

Giant mosquitoes of the genus *Toxorhynchites* require special consideration in this paper.

Toxorhynchites.—Two species of these giant mosquitoes are found extensively in the port of Calcutta (1) with banded legs and (2) with unbanded legs. They are rare in the centre of Calcutta but are common in the suburbs—a probable reason for their avoidance of the city being the absence of succulent trees: they are vegetarians and do not suck blood. They are plentiful on the banks of the Hoogly below Calcutta. As with *stegomyia* their favourite breeding places are earthen pots: there is usually mud or sand at the bottom of the pot. Their larvæ are seldom found in the same receptacle along with larvæ of other genera: they are usually found alone and generally in very small numbers—only from one * to four specimens in each receptacle. The reason is that the larvæ of *Toxorhynchites* are carnivorous and eat up the larvæ of other genera, and in the absence of larvæ of another genus, they eat one another, the largest and strongest larvæ surviving. The adults apparently do not bite man or suck blood.

The adult female lays her eggs while on the wing hovering just above the surface of the water. The eggs are white in colour, globular and laid singly, some distance apart. After some 12 hours the eggs become oval. Under the microscope the surface of the egg is seen to be jagged or prickly. In about 40 hours the egg-shell bursts and the larvæ emerge.

The larvæ are stout and whitish but soon acquire pigment, at first bright red, then dark red and finally brown. When fully grown they are about $\frac{3}{4}$" long. From the time they are hatched their carnivorous habit and cannibalism are manifested. If other mosquito larvæ are not available, they eat one another. In the absence of other living larvæ of another or of their own kind, they will eat dead larvæ and failing dead larvæ they seem to live on vegetable matter.

The manner in which they devour other larvæ has been described by Paiva. We agree with all Paiva says except that the larvæ of *Toxorynchites* does not lay hold of any particular part of the anatomy of the victim but seizes the victim at whatever spot happens to be nearest and within convenient reach—sometimes thorax, sometimes tail, etc.

A larva of *Toxorhynchites* can kill larvæ of *stegomyia* three or four times its own size. An ordinary larva of *Toxorhynchites* can easily dispose of half-a-dozen good-sized larvæ of another genus in about half an hour.

* In one instance about a dozen larvæ of *toxorhynchites* were found in one and the same receptacle; but some larvæ of other genera were present.

I. Measures suggested to destroy Stegomyia fasciata—

A. To diminish the number of their breeding places which are all provided by men—

(*a*) *Movable receptacles, e.g.*, earthen pots, etc., to be properly disposed of. Here the value of systematic concerted action on the part of the citizens would be immense.

(*b*) *Fixtures*—Buildings and masonry structures.

Engineers and builders. { No hollows left capable of retaining water, mosquito proof lids to cisterns and other water receptacles, good drainage for rain and sullage water.

B. To destroy their larvæ—

To provide a certain number of traps in which *Stegomyia fasciata* would lay its eggs and to breed for these traps a healthy stock of young larvæ of genus *Toxorhynchites.*

II. Measures suggested to lessen the risk of the introduction of yellow fever.—Vessels coming from infected ports should not be allowed up the Hooghly within a certain number of miles of Garden Reach. This loading and unloading and quarantine station should be in as isolated a spot as possible—as far from large villages as possible; and no huts or buildings (other than those necessary for crews, passengers and cargo) should be allowed to be erected at that spot or within a certain radius of it. With yellow fever we have not got to consider latent infection and infection-carriers as we have to do in the case of malaria. Protozoal diseases are of two kinds—

(1) The protozoa remain in the body after convalescence and so are capable of carrying infection after recovery from fever, *e.g.*, malaria, trypano somiasis.

(2) The cause of the illness disappears from the body with convalescence, *e.g.*, relapsing fever, yellow fever. So these measures, combined with fumigation, should eliminate the dangers so far as infected people and infected mosquitoes are concerned. That infected mosquitoes can transmit the infection to their offspring has not, so far as I know, been confirmed. If confirmed, the problem of preventing infected mosquitoes' eggs, especially in a dried state, from reaching Calcutta would be a difficult one. I show you a tube-bottle in which a stegomyia was enclosed and forgotten. Days afterwards the tube was casually examined. It contained the shrivelled body of a mosquito and on the walls and bottom of the tube were seen numerous stegomyia eggs which must have been laid in a dry tube. Water was added to the tube and in a few hours numerous minute stegomyia larvæ were wriggling about. It is interesting to observe the cap or lid at the broader end of the egg. This cap drops off when the larvæ emerges.

NOTES ON DISTRIBUTION AND HABITS OF STEGOMYIA MOSQUITOES IN MADRAS.

By Captain J. H. Horne, I.M.S.

The following notes are based on a three weeks' survey undertaken in order to find out, for the purposes of this Conference, the species, distribution and habits of stegomyia mosquitoes in the town of Madras. The original scheme for a stegomyia survey of the main Madras ports has not yet been sanctioned, and these notes cannot be taken as in any way representing the results of a complete survey.

Species.—Two species of stegomyia occur here, viz.—

(1) Fasciata.

(2) Scutellaris.

Fasciata is the more widespread of the two and is essentially a house mosquito; scutellaris is common where there are trees, and is in Madras at least, apparently an out-door mosquito.

I. *Stegomyia fasciata.*—Its breeding places may be classed as follows:—

(1) All sorts of *receptacles* containing water, *e.g.*, earthenware gurrahs (by far the commonest), tins, tubs, flower-plots, fire buckets, pails, mill stones, etc.

(2) *Drains*, open and underground.

(3) *Wells*, surface and deep; both indoor and outdoor.

In receptacles they were usually found along with steg scutellaris, Sc. sugens and N. M. rossi; less often with Cul. fatigans and tæniorhynchus. As a rule these receptacles were lying about in compounds but were sometimes in very exposed places, *e.g.*, flower pots on the roof parapets of two storey buildings.

It is only in the harbour that the larvæ have been found to occur in drains: and here the mosquito is so abundant as to constitute a serious hindrance to work in the offices and goods sheds.

The larvæ were taken—

(1) in an open cement drain round the goods office,

(2) in a covered underground drain round a loading shed.

The latter drain was roofed over with stone slabs between which were numerous chinks and spaces permitting easy access to the water below.

No stegomyia larvæ have so far been got in the drains in the town.

Their presence in wells was first detected in a "deep" house-well in Georgetown, so dark that the surface of the water could only be seen with difficulty. Further search revealed them in an out-door well ("deep") in a neighbouring compound; and again in a surface well in an open space in another part of the town. The chances are that their presence in such wells is widespread. The first well was in use, the others were not.

In these wells they were found along with Neoc. "stephensi" and Cul fatigans.

Fasciata larvæ were not found in open pools, ditches, or bamboo stumps.

This mosquito (steg. fasciat) was found to be generally present throughout the city, though in greatly varying numbers 8 out of the nine main divisions of the town were visited and in seven of these it was met with. It was most abundant in the harbour and the adjoining district of Georgetown.

The adult fasciata were almost all caught inside houses and always in the close vicinity of a breeding place. Only a very few were caught in sheds stables and gardens. Their presence in huge numbers in the harbour goods "sheds" seems at first to contradict this statement, but these sheds are closed buildings and contain large numbers of coolies during the day.

In the town they seem to show a preference for better class houses of two or more storeys, possibly because of better breeding places (such as wells, flower pots, etc.), but in the mud huts of paracheries they were as a rule very scarce even when there were plenty available gurrahs close at hand.

In areas where adults were scarce the close association of adult and breeding place was very striking. In the Mylapore division of the town we searched one morning for an hour and a half without catching a single stegomyia adult or larva. On entering a large two storey house belonging to a vakil, a few adults were suddenly discovered and a close search revealed their breeding place in two flower pots in the house garden (the only two pots which contained water). Neighbouring houses were searched for more adults without success.

Again in the Pensioner Lines in Pursevakam, adults were taken in one quarter only and in that compound was an iron pot containing water which swarmed with fasciata larvæ.

As regards their well known habit of biting by day, the coolies in the Harbour sheds told us that the worst time was from about 9 to 12 in the forenoon and that after that they gave little trouble. We visited the sheds about 8–30 A.M. and 5 minutes inside was about as much as we could stand.

In the Madras Club however I have myself occasionally been bitten by fasciata between 7 and 10 P.M.

Several of the females caught deposited eggs in the laboratory. Some of these eggs sank, other floated, others stuck fast to the blade of grass introduced to keep the water sweet. The sunken eggs were compared under microscope with those that floated but no difference (*e.g.*, damage to outer coat) could be detected. These hatched out within five days.

Sleg Scutellaris.

II. *Stegomyia scutellaris* has been found breeding in—

(1) *Receptacles* containing water, *e.g.*, earthenware gurrahs and flower pots,

(2) *Bamboo stumps*,

and always close to trees.

They have not been taken in drains or wells or open pools.

Not a single adult has been caught inside a house or hut of any sort, even when their larvæ were within 6 feet of the door.

In gardens, both large and small, they are fairly common and here are easily captured owing to the persistence with which they attack one. In Pusa this species was a household pest, and it is likely that though here they apparently keep closely to gardens they venture into houses for blood. Still it is worthy of note in one Paracheri where they were very numerous, the inmates made no complaint whatever of mosquitoes biting them.

Of other mosquitoes found mention may be made of—

(1) *Desvoidya*, the larvæ of which were found together with faligans in a surface well near the sea. Adults were taken in neighbouring houses.

(2) *Scutomyia Sugens*, whose larvæ were found in earthenware gurrahs together with scutellaris.

(3) a genus of mosquito which appears to be a *Reedomyia*, but this requires confirmation.

Adults of these genus were taken in a wood in Nungambakam: its larvæ were not discovered. These three genera are closely related to stegomyia in scale structure, and resemble it in their vicious habit of biting by day.

Remedial Measures.

Not enough has been done to allow of a definite plan of campaign being drawn up, but the following measures suggest themselves as being necessary in order to stamp out the stegomyia fasciata:—

(1) House-to-house inspection by a trained staff; and after due warning, the fining of those in whose houses or compounds stegomiya larvæ are found.

(2) The regular flushing of drains.

(3) Closure of all wells where a tap supply is available, roofing in other cases.

(4) The plastering of bamboo stumps (scutellaris being a possible carrier).

In closing, my sincere thanks are due to Dr. Macdonald for his kindness in placing his Sanitary Inspectors at our disposal, a favour which greatly facilitated the work.

A BRIEF REPORT OF THE STEGOMYIA SURVEY IN THE PRINCIPAL PORTS OF BURMA.

By Major N. P. O'Gorman Lalor, M.B., D.P.H., I.M.S.

The Stegomyia Survey of Rangoon town was commenced in January of this year. The preliminary report was published as Appendix VI to the Annual Report of the Provincial Malarial Committee, Burma, for the year ending 31st March 1912; this report was furnished by Assistant Surgeon D. Ananda Rao. In my remarks published therewith, I pointed out that Stegomyia extinction in Rangoon (and the same is true of other large ports) being one of house sanitation was essentially a municipal problem.

The services of Military Assistant Surgeon Mr. D. D. Stewart were made available by the local Government for three months with effect from the 10th of September 1912 as my assistant in completing the work at Rangoon, and conducting similar investigation at the ports of Akyab, Bassein and Moulmein.

As far as Rangoon is concerned certain prominent facts emerge from investigation. These are as follows:—

(1) Stegomyia is abundant in the rains and is relatively scarce in the dry season. The months February to May, inclusive, offer the most promising period for the success of general efforts directed towards Stegomyia destruction.

(2) In the dry season Stegomyia breeding places, scarce in East Rangoon, are more abundant as one proceeds westward. In the wet season breeding places are numerous all over the town including Kemmendine and Syriam.

(3) Rain water barrels, tubs, and old earthenware pots form the commonest breeding places; fire buckets come next; if these sources alone be eliminated Stegomyia breeding in Rangoon would, it is reasonable to estimate, be reduced by three-fourths. Other places in which Stegomyia has been found to breed are as follows:—washing tubs, water receptacles under the legs of meat-safes, cup-boards and tables, water in flower vases, traps under disused laboratory basins, black-smith's cooling troughs, old kerosine tins, Pegu jars, and flushing tanks of disused private latrines.

(4) In general the larvae of Stegomyia have been found capable of breeding in stale water found in artificial containers of every kind, the essential condition appearing to be the absence of larvivorous forms of aquatic life. They have been found breeding in barrels side by side with culex larvae, but have not been found to breed in unpaved drains, ponds, or other natural water collections.

(5) Of the breeding places mentioned—all domestic in character—some exist necessarily; such are rain water barrels, tubs, fire-buckets, and small receptacles under the legs of meat-safes, cup-boards and tables. Of the remaining receptacles some, as for example flower vases, are ornamental, and carelessness is responsible for the operation of the rest. Exceptional breeding sites, such as the traps of disused laboratory basins and the flushing tanks of disused private latrines, are so rare as to be practically unimportant.

(6) In general, the more waste ground and the more vegetation exist within house and factory premises, the greater appears to be the number of unnecessary water receptacles in which Stegomyia breeds.

(7) It may be inferred that general measures especially adapted for Stegomyia destruction will provide for (*a*) the abolition of all unnecessary water receptacles, (*b*) treatment with effective larvicide of water in necessary receptacles which are large, *i.e.*, rain water barrels and tubs, and (*c*) regular and frequent change of water in necessary receptacles which are small, such as fire-buckets, small receptacles under meat-safes, cup-boards and tables, and flower vases. The preceding remarks apply also to Akyab where *Stegomyia Fasciata* has been found breeding extensively in similar situations to those in which it has been found breeding at Rangoon.

Five mounted photographs exhibiting typical breeding places in Rangoon are circulated for inspection. Lantern slides of these, and of the life history of *Stegomyia Fasciata* have been prepared with further slides of explanatory text. These are also circulated.

Life history and habits of Stegomyia Fasciata.—A small pamphlet regarding the life history of Stegomyia with illustrations of the egg, larva, nymph, and adult has recently been published by the Superintendent, Government Printing, Burma, and is available for general distribution. Dr. Stewart has observed in the course of his survey at Akyab that the townspeople in many instances have their rain-water tubs thoroughly cleaned, and water in flower vases changed, as they were afraid of being prosecuted should larvae be found present. This experience foreshadows the results that may be expected from effective legislation. Dr. Stewart has observed that Stegomyia larvae are shy and timorous and that they wriggle down to the bottom of the containing receptacle on the least disturbance; even if shadow be projected on the water. He recalls in one instance that no larvae were discovered on pouring out the water from a vase, while on pouring the water back into the vase and shaking it, larvae were dislodged. Larvae will often cling to the sides of a receptacle or hide in the ridges between the staves of a barrel. It is noteworthy that rain-water tubs which originally contained coal-tar are not selected by Stegomyia for breeding purposes, though such contained water possesses no larvicidal virtue.

Note.—The speed with which the larva of *Stegomyia Fasciata* wriggles to the bottom of the receptacle is in marked contrast to the slowness and difficulty with which it rises to the surface, and the amount of horizontal room it appears to require for the latter purpose. Experiments of a mechanical nature are projected to see if advantage can be taken of this fact in their destruction.

Laboratory experiment conducted with a view to the discovery of a cheap and effective larvicide.—The condition it was sought to fulfil is the destruction of all Stegomyia larvae within a period of 5 minutes after the addition of larvicide. This condition is imposed in practice by the heavy rainfall of Rangoon, which at any time after the addition of larvicide to rain-water barrels and tubs might so dilute the larvicide as to render it ineffective.

The larvicide devised by Colonel Gorgas, U.S.A., was first experimented with, but the crude carbolic acid locally procurable was found ineffective even though the modified formula suggested by Dr. Bentley in the report of his investigation into the causes of Malaria in Bombay was tried.

The other larvicides tried were as follows :—

Quick lime, 2 oz. per gallon of water.

Common alum, 1 in 2400.

Permanganate of Potash, 1 in 2400.

Lysol, 1 in 1250.

Cyllin, 1 in 1250.

Coal-tar and turpentine equal parts, emulsified with ·075 grms. of Hudson's extract of soap to each 2 c.c., 1 in 2500.

Turpentine alone, 1 in 2500.

Dr. Bentley's modification of the Gorgas formula, with Phenyle substituted for Carbolic Acid.

Of these the following alone were found to satisfy the required condition :—

Cyllin 1 in 1250 (one teaspoonful to a gallon).

Coal-tar and turpentine equal parts, emulsified with ·075 grms. of Hudson's extract of soap to each 2 c.c. 1 in 2500 (one teaspoonful to 2 gallons).

Gorgas formula with Phenyle substituted, 1 in 1250 (one teaspoonful to a gallon).

No.	Larvicide.	Species tried upon.	Strength.	Result.
31	Rx. c. ... Coal-tar 5 c.c. ... Benzole 5 c.c. ... Water 90 c.c. ... Soft soap 0·7 grammes	Stegomyia larvae.	1 in 100, *i.e.*, 1 in 2000 of coal-tar.	All practically killed in 2 minutes. Complete cessation of movement in 4 minutes. Nymphae unaffected at the end of 30 minutes.
32	Do. ...	Do. ...	1 in 200, *i.e.*, 1 in 4000 of coal-tar.	All practically killed in 4 minutes. Complete cessation of movement in 7 minutes.

It is possible that amongst coal-tar products of the phenol group a more effective larvicide may yet be discoverable, and further experiments will be conducted to this end.

Final remarks.—In addition to *Stegomyia Fasciata*, *Stegomyia Scutellaris* and *Desvoidea Obturbans* have been found to breed in Rangoon, but far less extensively than *Stegomyia Fasciata*. While no distinction has been observed between *Scutellaris* and *Fasciata* as regards their choice of breeding places and both have been found breeding together, *Desvoidea Obturbans* has been found especially to breed in water in the hollows of cut bamboo.

The survey is at present in progress at Bassein and will be continued at Moulmein, after which a full report will be submitted through the Sanitary Commissioner, Burma, and the Inspector-General of Civil Hospitals, Burma, to the local Government.

STEGOMYIA FASCIATA.

Professor F. M. Howlett, Imperial Pathological Entomologist.

The genus *Stegomyia* is characterised by the head and scutellum being entirely clothed with flat scales. There are several genera nearly related to it. *Stegomyia fasciata* is the only species definitely known to carry Yellow Fever, but it is by no means impossible that other members of the genus might do so. There are some half-a-dozen species not uncommon in India, *S. scutellaris* being particularly abundant. The adult *Stegomyias* are easily distinguished by the pattern of the light bands or spots on the back. *S. scutellaris* has a single white stripe, *S. fasciata* four light stripes of which the outer pair are curved.

S. fasciata seems to be very rarely if ever found away from human habitations, and appears to be common in most if not all of the larger coast-towns of India. It does not as a general rule breed in very dirty water, and selects such places as (wells ?) cisterns, barrels, jars and earthen vessels, flower-pots, fire-buckets, cans, sardine tins and the like, though it is sometimes found in the dirty water of open drains.

The plan adopted to check *Stegomyia* at Pusa has been to eradicate as far as possible all natural and accidental breeding-places, but at the same time to supply artificial breeding-places (cut joints of bamboo filled with water) which can be emptied out every few days, and so controlled.

Individuals bred in captivity at Pusa have given the following periods as the average for the different stages. Pairing takes place about twelve hours after the female has emerged from the pupa, and is followed by a meal of blood. From two to four days later the female lays about fifty eggs, which begin to hatch after 48 hours, though some of them may not hatch until several days later. The length of the larval period varies considerably according to the suitability of the conditions, the shortest time observed between the hatching of the eggs and the pupation of the larvæ being five days and the longest twenty-two; a week may be taken as a likely average. The pupal stage lasts from two to three days, and the adult mosquito then emerges. The larva may be distinguished from all other *Stegomyia* larvæ which occur at Pusa by the presence on the thorax of four conspicuous chitinous hooks, which can be seen with a hand-lens; These hooks are not present in the very young larva. The egg and pupa are of the usual *Stegomyia* type. The adult rarely if ever bites after dark, but is particularly bold and troublesome by day.

In the case of all those *Stegomyias* which occur naturally at Pusa (these do not include *S. fasciata*) eggs laid in the cold weather do not hatch until the following rains, lying in earth and dried mud throughout the whole of the dry season. In those places which have a well-marked cold or dry season, the same thing will in all probability be found to happen in the case of *S. fasciata*, as its eggs are known to retain their vitality for weeks or months in a dry condition. In places with an equable warm moist climate they may very possibly breed all the year round.

A PAPER ON THE ÆTIOLOGICAL RELATIONSHIPS OF SEVEN-DAY FEVER.—A SUGGESTION.

(Read by Major N. P. O'Gorman Lalor, M.B., D.P.H., I.M.S., before the Burma Branch British Medical Association at Rangoon, on September 10th, 1912.)

Amended for publication in proceedings.

In the course of the *Stegomyia* survey of Rangoon, I have been struck with the fact that seven-day fever appears to be localised in its distribution, in a manner which suggests its association with the local prevalence of *Stegomyia fasciata.*

Captain Megaw, I.M.S., in an able thesis—suggested that seven-day fever was really identical with dengue, but there is now, I believe, a consensus of opinion—shared by Major Rogers, the distinguished author of the work "Fevers in the tropics"—that this view is incorrect. We know the part played by *Stegomyia fasciata* in conveying yellow fever from man to man, but otherwise we know very little of its disease-carrying capabilities. There may very possibly be a group of diseases possessing certain features in common, which we might term "*Stegomyia diseases*"; and the reason why we have not hitherto discovered more about these may lie in the peculiarly short duration of the period during which the infective agent in the blood of man, is viable as regards the mosquito. Such a short duration we know to be characteristic of the materies morbi of yellow fever. If seven-day fever be also a *Stegomyia* disease, there is room for supposing that the connection has been hitherto difficult to trace on account of two factors: (1) the frequency with which patients fail to seek medical treatment, and come under expert observation—during the first three days of the disease, and (2) the possibility that the materies morbi in seven-day fever may—if the relative mildness of that disease is any criterion—be viable as regards the mosquito, for a period even shorter from the commencement of the disease, than that which obtains in yellow fever.

In this age of medical discovery what we require is not theory, but fact and proof. Nevertheless as one of our most tried and valued methods of arriving at the truth, we frequently have recourse to the process of exclusion. Before doing so it is necessary for us to clear the ground only to the extent of showing (1) that there is no inherent improbability in our suppositions, and (2) that there is between the disease, with the ætiology of which we are acquainted, and that, the ætiology of which we are investigating, a certain analogy as regards the climatic and local peculiarities of their distribution, their seasonal occurrence and their connection with the local prevalence of a definite infective agency. Should our theory fail of demonstration, we still have the satisfaction of reflecting that we have been instrumental in clearing the ground for subsequent workers in the same field.

This must be my apology for the views put forward in this paper. Should they eventually prove true—and I shall presently indicate the steps necessary to their proof or disproof—we are at once provided with a most valuable weather gauge in India and *Burma*, for estimating the risk of dissemination of imported yellow fever—a risk upon which the expected opening of the Panama Canal has focussed attention. We should be able, as long as seven-day fever persists in the great sea-port towns, and especially at times of seven-day fever prevalence, to assert a definite risk of the dissemination of imported yellow fever, and the suggestion if its grounds be true, possesses sufficient intrinsic importance to justify its author in laying stress upon it.

I have now to justify my position by instituting some comparison between seven-day fever and yellow fever, and I think gentlemen, you will admit when I have done so, that there is reason for regarding seven-day fever as closer in its ætiological relationship to yellow fever than to dengue. It will then remain for me to suggest the lines upon which investigation should proceed.

Points of comparison.	Seven-day Fever.	Yellow Fever.
1	2	3
1. Geographical distribution of the endemic disease.	Indian sea-port towns :— (Calcutta, Rangoon, Madras and Bombay).	Tropical and sub-tropical zones, especially hot and damp sea-port towns.
2. Usual seasonal incidence.	May to September. Europeans most susceptible.	The hot weather. Europeans most susceptible.
3. Incubation period ...	Not known	Three to five days.
4. Onset	Usually sudden	Usually sudden.
5. Symptoms and physical signs.	1. Face usually flushed	1. Red and swollen face.
	2. Palpebral conjunctiva a vivid red coloration.	2. Injected conjunctivæ.
	3. Pulse presents constant and characteristic slowness in proportion to the temperature.	3. Pulse full and strong but soon becomes disproportionately slow.
	4. Abdomen often distended and the seat of pain.	4. Oppression and pain in epigastrium.
	5. Sickness in 25 per cent. of cases and nausea in 18 per cent. more.	5. Vomiting.
	6. Skin : a mottled rash in 7 per cent., sometimes morbilliform.	6. Skin : Erythematous; may be morbilliform, necks, chest and abdomen.
	7. Temperature high evening of 1st day ; gradually declines to 3rd morning ; 100° F., 3rd and 4th days ; secondary rise 5th and 6th days.	7. Temperature maximum 24 to 36 hours. Third day temperature and pulse fall, headache abates. Convalescence : or gastric symptoms return and increase. Temperature again rises, and black vomit may set in (5th or 6th day).

ÆTIOLOGICAL EXPERIMENTS SUGGESTED REGARDING SEVEN-DAY FEVER.

1. Stegomyia fed on seven-day fever patients, during each day of the fever commencing from that of onset, might be conveyed to a centre in Burma where neither dangue nor seven-day fever are prevalent and fed after an interval varying from 7—14 days, on the blood of volunteer subjects—to see if the latter get the same fever subsequently.

2. Such volunteer subjects might be kept under observation, and the incubation period, symptoms, and duration of any subsequent fever would be noted. (They would of course be examined beforehand, to exclude malarial infection.)

3. Experiments might be conducted in two series, the first to establish carriage of infection by *stegomyiæ fed* on the original patient during a definite period after onset of the fever, the second to establish the non-carriage of infection by *stegomyiæ fed* subsequently.

4. If the experiments are analogous in their results to those which were made in the case of yellow fever, seven-day fever would be found not to be transferred by the infected *stegomyia*, till after the lapse of a definite period in days from that on which it was fed on the original patient.

5. ·1cc of serum taken from a seven-day fever patient, during a definite and short period from the onset of his illness, might produce the same fever in a healthy person if injected under the skin.

6. Such serum after exposure to the air at a temperature of 24 to 30c. might be inert at the end of 48 hours. The same result might follow exposure of the serum to a temperature of 55c. for five minutes.

7. A general enquiry might be instituted at seven-day fever centres, with the object of mapping out the affected areas with as great an approach to accuracy as possible and comparing these areas with the areas—coincidently mapped out at these centres—of *stegomyia* breeding and prevalence.

THE BREEDING-PLACES OF PHLEBOTOMUS.

Professor F. M. Howlett, Imperial Pathological Entomologist.

The investigation of the natural breeding-places of sand-flies is by no means easy, owing to the minute size of the larvæ and the fact that their colour harmonises with that of damp earth. Repeated attempts have been made at Pusa to discover whether the breeding-places were restricted to one particular type of locality on which it might be possible to concentrate the application of remedial measures. Our experience indicates that no such definite assertions can be made in a district where the climatic conditions are such as obtain at Pusa, although it is probable that breeding-places may be found to be far more narrowly restricted in such areas as the Punjab, where temperatures are higher and humidity low, since a certain degree of moisture in the soil is essential to the welfare of the larvæ; they are never found in really dry earth, and are killed by a comparatively short exposure to the dry air of the hot weather. In very dry areas we should thus expect to find them only in those places where there was a reasonable amount of moisture, and the difficulty of finding them would thus be considerably lessened.

Although the number of larvæ found has been small, it is sufficient to show that in Pusa the necessary conditions are :—

(1) a moderate degree of moisture, roughly equivalent to that of good garden mould in England;

(2) protection from light;

(3) the presence of nitrogenous refuse; particularly the debris of dead insects, decayed fungi, and perhaps insect and other excreta. An excess of nitrogenous matter, however, appears to be distasteful and unsuitable. No larvæ have been hitherto found in latrines although search has been made on several occasions;

(4) the presence of brick, stones, tiles, or cement has been associated with all but one of the breeding-places seen hitherto; this is probably due to the fact that these substances are comparatively cool and often have condensed moisture on the surface, while they also act as a protection from the light. Grassi has found larvæ in cellars and damp places where there were bricks, and Marett in Malta only found them in caves and in the crevices of stone walls, while it has been suggested that they feed exclusively on the excreta of wood-lice. All these observations fit in with the conditions outlined above. The brick-work of wells is indicated as a promising locality in dry districts, though no results therefrom have yet been got at Pusa.

Two other points are worth noting. One is the very frequent association of sand-flies with the common wall-lizards; the flies bite the lizards readily, particularly the young and tenderer individuals, and are often to be seen sitting on or near a lizard; the latter seem to suffer no annoyance from the bite. It is very possible that the cracks and crannies in the wall in which lizards reside during the day are sometimes used by *Phlebotomus* as breeding-places, and the excreta of the lizard, consisting as it does of the remains of digested insects, might provide suitable food for the larvæ, though these have not yet been found in lizards' haunts. The other point is the possible utilisation as breeding-places of the nests of termites. I have twice observed adult *Phlebotomus* in some numbers in the surface-galleries of these nests, but have had no opportunity as yet of pursuing the matter further, as nest-building termites do not occur in the Pusa district. Mr. Fletcher writes that he has observed the same thing while working at termites in Madras, and since the nests would provide just the right conditions as regards moisture, darkness, the presence of nitrogenous refuse, and even the brick-like walls of the galleries, this line of investigation seems a promising one.

The following are the localities from which larvæ or pupæ have been obtained at Pusa :—

1. The nearly dried mud of cement channel leading from a well-reservoir. *One larva. August.*

2. A small heap of kitchen-refuse near the base of a wall. *One larva. August.*

3. The damp earth between the bricks forming a small platform for a plant of the sacred *Tulsi*, in the courtyard of a house. The bricks were more or less covered with an algal growth, and among them were found ants, with larvæ and nymphs, wood-lice larvæ of *Mycetophilidæ*, mites and a few nematode worms, together with the remains of numbers of dead insects of various sorts, on which the larvæ were feeding. *Four larvæ and seven empty pupa-cases. October.*

4. Among the bricks and tiles in a small heap of earth and rubbish. The conditions were similar to those in the locality just mentioned, the larvæ feeding on fragments of dead insects. The heap was about a foot high, on a piece of waste land some thirty yards from a block of houses. *Five larvæ, three pupæ, and twenty-three empty pupa-cases.* The pupæ were nearly all on the edges of tiles and bricks; they can be recognised by the fact that they stand upright, anchored to the support by the larval skin which remains encasing the tail-end. The larvæ (2—3mm. long) can be recognised by the two or four very long stout bristles at the tail.

5. The damp algal muddy leafy stuff taken from the earthy sides of an open reservoir where water from several gutters accumulates: the gutters, which are of cement, lead from houses and the water contained nitrogenous matter. *Six adults emerged. May.*

KALA AZAR, ITS DISTRIBUTION AND THE PROBABLE MODES OF INFECTION.

By Lieutenant-Colonel C. Donovan, B.A. M.D., B.C.H., B.A.O., (R.U.I.), F.L.S., F.E.S., I.M.S., Surgeon, 4th District, Madras.

In this paper I shall give a brief account of the geographical distribution of this disease to show the nature of the localities in which it is endemic. Its occurrence in such places may help to throw a side-light on some of the factors needed towards the discovery of the infective agent. I shall then instance the different insects that have been suspected as transporters of the ailment and the possibility of infection by means of or through the mucous membrane of the intestinal tract.

Geographical distribution.—Outside India, we have records of the prevalence of the disease in China, in the Yangtse Valley and in the Soudan, in localities on the Blue Nile bordering the western boundary of the Abyssinian plateau.

The disease as found along the littoral of the Mediterranean we may at present exclude and relegate to another form of Leishmaniasis, as this affects mainly, if not exclusively, children and apparently is closely connected with the canine form of the disease. It is true cases of Mediterranean Kala Azar have been found in adults in Greece and a few in the south of Italy, but our knowledge of the European type is still in a very unsettled state as far as some aspects of the disease are concerned.

To come to the occurrence of kala azar in India, the part which is of special interest to us out here ; it is found endemic in the damp, low-lying districts near the deltas of the Ganges and Brahmaputra ; for instance, at Purneah, Dinajpur, Rangpur, Burdwan district, Jessore, in and about Calcutta, Garo Hills and up the valley of the latter river in Assam.

To make a short digression, the disease in Assam is said to take on an epidemic character, a feature unusual to this affection as noticed elsewhere. I strongly suspect that the epidemics in question were of malarial origin and not due to Kala Azar.

I am doubtful if Orissa is affected, but would suspect the low-lying areas of the deltas of the Brahmani and Mahanadi rivers, especially near Cuttack, to be suitable localities. An interesting question to ask some of the delegates present would be, if the coolies working in the Assam Tea-gardens were Ooriyas, and, if so, could the infection have been carried by them to Assam ? To support this supposition we must first have evidence that kala azar exists in Orissa. Cases occurring in other parts of the north of India are apparently not indigenous. Dr. Row's case of kala azar from Baroda is an exceptional instance, perhaps others may be discovered there when more searching inquiries are made.

As far as this Presidency is concerned the disease is endemic in Madras City, especially in the northern congested part, *i.e.*, Georgetown and Royapuram ; to the west we have smaller foci in Choolai, Vepery and Pursewalkum, and to the east a very small focus in Triplicane.

Recently a single case has been discovered in the family of a servant employed by a European residing in Nungumbakam, the residential part of Madras for Europeans. I shall further on enter more into details of this interesting occurrence.

In the *mofussil*, three cases have been traced to Madura and a couple to Negapatam and Cuddalore.

Thus all the places where this disease is endemic are low-lying, damp and near rivers ; places very suitable for malaria and here malaria and kala azar co-exist.

Probable modes of infection.—These may be divided into two :—(1) By means of insects, etc., absorption of the infection by the cutaneous lymphatics and (2) by oral ingestion, infection through the mucous membrane of the intestinal tract.

(1) *By insects*—(*a*) *Bed bugs.*—Captain Patton has brought very strong evidence to bear on the transmission of the disease by bed bugs; yet there are several points still wanting to satisfy us in accepting the fact in its entirety. The disease is very local and bed bugs everywhere. Captain Patton has attempted to explain this anomaly by the fact that a few bugs may take a single meal only of blood, the majority satisfying their appetites more often and not being condemned, for some unaccountable reason, to an unnecessary fast; and that it is in these exceptional cases of single feeds that the Leishmaniæ flourish and flagellate. There may be something in this deduction, but further proofs are required. Captain Patton has done a considerable amount of work in connection with bugs and can speak with authority, yet we need an independent confirmation of his findings. I have myself worked on a very small scale but met with no success. I have not had an opportunity of trying experiments with the single feeding of bugs; cases of kala azar with numerous Leishmaniæ in the peripheral blood are of rare occurrence. Subsequent to Captain Patton's announcement of success with single feeds, he has, I understand, fed bugs on a kala azar patient with nearly a thousand Leishmaniæ in a blood film. Large numbers of these insects were fed on this most exceptionally suitable case, the results, I am credibly informed, were negative. Of course, conditions favourable on the first occasion might have been inimical on this the second attempt, for the flagellation of the parasites; for instance, there may not have been a sufficiently large number of Leishmaniæ in the endothelial cells. Doubtless Captain Patton will enlighten us on this, his most recent endeavour at bringing about pullulation of Leishmanio Donovani in the bed bugs.

(*b*) *Conorrhinus.*—It is known that I have suspected another member of the bug family to be a transmitter of the disease, *i.e.*, Conorrhinus rubrofasciatus; an impression has arisen among workers not well versed in the practical experimentations on the subject of Leishmaiases, that I was certain of the transmitting powers of this insect; for instance, here is an extract from a recent number of the kala azar Bulletin: "this finally proves that this bug has nothing whatever to do with the transmission of kala azar." This assertion was based, I presume, on Captain Patton's experiments with this bug.

I do not wish to push the claims of this insect to an unnecessary extent, but it must be admitted that the animal has not had an equal chance, or if I may be permitted to use racing parlance, "a fair field" with the bed bugs. So far I have not succeeded in obtaining any pullulation of Leishmania Donovani in the gut of these Hemiptera, but what makes me still adhere to experiments with them, is the fact that they suck human blood under natural conditions and that another species of the same genus in Brazil is the transmitter of a human trypanosomiasis. The popular belief that this bug feeds on the bed bugs is of curious interest, and a similar belief is held in Europe with regard to its congener, Reduvius personatus. Could these Reduvilid bugs procure the blood second hand, *i.e.*, by sucking the bed bug and not directly from man himself? I am not certain of the distribution of Reduvius in Europe, but I am under the impression that it is found along the Mediterranean coast and may have some connection with infantile kala azar. This is a mere surmise, but work in these regions on the life history of these bugs may prove of great interest.

(*c*) *Mosquitoes.*—Very little experimentation has been done with these Diptera. In Europe, Anopheles claviger (maculipennis), has been indicated on very slender grounds however. Captain Patton has carried out a few observations on these insects but with negative results. It must not be forgotten that some Culicids harbour flagellates and these may very readily be confused, by an inexperienced observer, for Leishmaniæ. A fact to be noted is, that the localities where kala azar is endemic, there too malaria prevails; to give a few instances; in Assam, in lower Bengal and in our city in Georgetown.

A very interesting case bearing on this association of malaria and kala azar is one I have recently come across in the compound of a European in Nungumbakam. A daughter of one of the servants, aged about 13 years, who is said to have been born and to have lived all her life within the precincts of the compound, never having left it for a single day. During the last three months the father and the three daughters have suffered from fever. Their blood was

examined and it was found that the father and the two younger daughters had malaria of the benign tertian type; while the eldest who had lived and shared the same room as the others was suffering from kala azar, no malarial parasites were found in her blood. As I mentioned before, Nungumbakam is a very healthy locality where a number of well-to-do Europeans reside, no malaria or kala azar has been introduced here before. This is an individual case and an exception to what usually occurs, kala azar being more prevalent in congested quarters inhabited by natives of the country. It may be mentioned incidentally, that Conorrhini, both adults and nymphs, are very common in this compound.

(*d*) *House fly.*—The ubiquitous house fly of India, very similar to that of Europe but singled out for specific distinction as Musca nebulo, has been incriminated as acting as a transmitter not by biting, as it possesses no such apparatus, but by transferring by its mouth or excreta the *materies morbi* on to foodstuffs or on a breach of surface. This fly has a Herpetomonas of its own and a very distinctive one, in several ways differing from Leishmania. I would place the Herpetomonas of the fly in a different genus, and consider it has no bearing whatsoever with the Leishmania of man.

(*e*) *Lice and Ticks.*—The head and body lice have undergone a trial at Captain Patton's hands and proved ineffectual as transmitters. Similarly a large tick, Ornithodorus savignii, has been put through a like ordeal of sucking the blood of kala azar patients with no positive results.

(*f*) *Fleas and Dogs.*—In Europe, especially with regard to infantile kala azar, the dog has been found to harbour Leishmania and a fairly presumptive case has been made out as to the part this animal plays as an intermediary host, the dog flea being the actual transmitter. But the evidence adduced so far is not in all respects convincing. The occurrence of a natural flagellate of the flea has evidently not been taken into sufficient account.

As far as the kala azar of India is concerned, the dogs examined out here have not afforded any evidence of harbouring Leishmania.

I have carefully searched in the spleen and liver of over a thousand dogs of this city which were destroyed in the lethal chamber in 1910, but was unable to find any signs of the parasite. Captain Patton has recently carried out similar examinations on a still larger number, the results of which I am not acquainted with, but I presume they will be confirmatory of my findings.

I have also injected the blood taken from the spleen of kala azar cases into two pups, and after an interval of about three weeks could detect no signs of Leishmania in their spleen and liver.

Very recently, on the 3rd July 1912, I injected into the liver of a pup, called "Gamma" aged 4 months, 3½c.c. of splenic blood (in ½c.c. of citrate of sodium solution) taken by splenic puncture of a kala azar patient in a moribund condition. The time between taking the blood from the spleen and injecting it into the liver of the pup was half a minute. The dog howled a good deal and vomited all its stomach contents. The patient was punctured at 6 p.m. and died at 10-30 p.m. the same night. The dog became thinner and more sluggish in its movements. On the 22nd of September 1912, the liver of this pup was punctured but no Leishmania found; the liver was reached as there were numerous hepatic cells in the smear. On the 6th October 1912, the dog was chloroformed and the anæsthetic pushed sufficiently to kill it. Smears were taken from the bone marrow of the ribs and these contained large number of Leishmaniæ in the endothelial cells. Smears on the other hand, from the liver and spleen had no parasites whatsoever. All the viscera of the animal were in a healthy condition, no enlargement of the liver, and the spleen was especially small and hard. This is the first time in India in which a dog has been successfully infected by a massive injection of splenic blood taken from a kala azar patient. A valuable lesson is to be learnt from this recent discovery. The bone marrow was not examined of the two dogs I previously injected, and in only a very small number of the 1,000 stray dogs killed in the lethal chamber in 1910. May it not be that dogs remain healthy and show no manifestation of disease as long as the Leishmaniæ are, so to speak, imprisoned in the endothelial cells of

the red bone marrow, but as soon as the parasites are shed and enter the general circulation that signs of disease arise and the Leishmaniæ are found in the spleen and liver? Further examination of the bone marrow of the dogs of Madras City is necessary before drawing definite conclusions.

(*ii*) *By oral infection.*—Having discussed the different kinds of insects that have been suspected of bringing about infection and spread of the disease, either by biting and so injecting or depositing the infective material on the skin, absorption by these means taking place by cutaneous lymphatics. I shall now turn to another channel by which infection may be possible, that is by the mouth, Leishmaniæ being ingested by food contaminated by excreta or other substances containing the encysted forms of this flagellate.

In a fairly large proportion of cases of kala azar, the disease begins with symptoms of intestinal involvement, simulating very closely cases of typhoid fever; the typical pyrexial course, the looseness of bowels and the gradual descent of the fever by lysis on about the twentieth or thirtieth day, presents a picture very like enteric.

After a period of apyrexia for a month or more, the temperature rises again, disillusionment of the diagnosis follows and kala azar is made manifest. Then again in the course of all cases of the disease, there are periods of diarrhœa and dysentery. In fatal cases evidence of ulceration of the large intestines is marked and Leishmaniæ are found in scrapings from these ulcers; involvement of the intestinal tract lends a certain amount of probability for suspecting a primal attack of the parasites on the mucosa of the alimentary system. It is true no Leishmaniæ have been found in the fæces of kala azar patients; ankylostomes and Trichomonads are frequent in such evacuations, could these organisms harbour and carry the Leishmaniæ and thereby bring about infection of the intestinal mucosa? Ankylostomes have been examined by Major Christophers, but he could find no trace of Leishmania Donovani in them. Trichomonads are very commonly found in infusions of earth, for instance, the earth containing intestines of white-ants are packed with these flagellates, and again saw-dust used in Madras for storing ice, on occasions affords a good supply of these protozoa. Could Leishmania be a commensal in the cytoplasm of Trichomonas? Flagellates are everywhere, even in the juice of plants, we have an instance in the common euphorbiaceous weed, Euphorbia pilulifera, in whose milky latex numerous herpetomonads are found.

So we see that the sources of infection are not limited to biting insects, and we ought to be chary in accepting any one channel of transmission without much further research.

Is Kala Azar in Madras of Animal origin?

By Captain W. S. PATTON, I.M.S.

Inoculation of animals with the pathogenic germs which cause human diseases has always played an important part in the elucidation of the etiology of such diseases, and we accordingly find that much work has been carried out in this direction in the case of Kala Azar. In this disease such experimental work is of the first importance, for owing to its fatal nature transmission experiments on man cannot be carried out. An additional reason for the further study of the disease in animals is due to the fact that the dog, and the cat, may naturally be infected with one of the parasites of Kala Azar.

Assuming that Kala Azar is an insect-borne disease, it is very necessary to ascertain whether the dog is the natural reservoir of the parasite in the endemic areas, for if this proves to be the case, we have in our power an important means of eradicating a disease, for which, as yet there is no cure. It will be quite unnecessary for me to review all the animal experimental work on Kala Azar, which was begun by Mackie in 1907 in India, and since followed up by Nicolle and numerous other observers in all parts of the globe.

It is now well known that Kala Azar along the Mediterranean littoral is a common disease of dogs and perhaps cats and it is generally believed that the human form is of canine origin. There are two obvious methods of discovering whether the dog is the natural reservoir, one by inoculating this animal with the parasite, and the other by examining *post mortem* all stray dogs destroyed in cities where Kala Azar is endemic. The following experiments and observations were therefore carried out to ascertain once and for all whether Kala Azar in Madras is of animal origin.

On May 14th, 1912, I obtained a spleen from a case of Kala Azar about three hours after death, it was brought up to the Institute as soon as possible, and a large quantity of the pulp was teased up in saline solution, and then ground up in a mortar under as near as possible sterile conditions. The following animals were inoculated :—

Monkey 1.—Three cc. intra-peritoneally and two cc intra-hepatically.
Monkey 2.—Four cc. intra-peritoneally.
Monkey 3.—Four cc. intra-peritoneally.

Dog 1.—Four cc. intra-peritoneally.
Dog 2.—Four cc. intra-peritoneally.
Dog 3.—Four cc. intra-peritoneally.
Dog 4.—One cc. intra-peritoneally, and one cc intra-hepatically.

Jackal 1.—Four cc. intra-peritoneally.
Jackal 2.—Four cc. intra-peritoneally, and two cc intra-hepatically.

Guinea pig 1.—One cc. intra-peritoneally.
Guinea pig 2.—One cc. intra-peritoneally.

Rabbit 1.—One cc. intra-peritoneally.
Rabbit 2.—One cc. intra peritoneally.

Cat 1.—One cc. intra-peritoneally.
Cat 2.—One cc. intra-peritoneally.

White rat 1.—One cc. intra-peritoneally.
White rat 2.—Three cc. intra-peritoneally.
White rat 3.—Three cc. intra-peritoneally.
White rat 4.—Three cc. intra-peritoneally.

Goat, young.— Four cc. intra-peritoneally.

Pig, young.—Seven cc. intra-peritoneally.

Calf.—Nine cc. intra-peritoneally.

On May 29th another spleen was obtained, and the above animals were re-inoculated as follows, with a splenic emulsion prepared as before :—

Monkey 1.—Three cc. intra-peritoneally.
Monkey 2.—Three cc. intra-peritoneally.
Monkey 3.—Three cc. intra-peritoneally.

Dog 1.—Four cc. intra-peritoneally.
Dog 2.—Two cc. intra-peritoneally.
Dog 3.—Two and a half cc. intra-peritoneally.
Dog 4.—One cc. intra-peritoneally.

Jackal 1.—Four cc. intra-peritoneally.
Jackal 2.—Four cc. intra-peritoneally.

Guinea pig 1.—Two cc. intra-peritoneally.
Guinea pig 2.—Two cc. intra-peritoneally.

Rabbit 1.—Not re-inoculated.
Rabbit 2.—Three and a half cc. intra-peritoneally.
Rabbit 3.—Four cc. intra-peritoneally (first inoculation).

Cat 1.—Two cc. intra-peritoneally.
Cat 2.—Two cc. intra-peritoneally.

White rat 1.—Two and a half cc. intra-peritoneally.
White rat 2.—One cc. intra-peritoneally.
White rat 3.—One cc. intra-peritoneally.
White rat 4.—One cc. intra-peritoneally.

Goat.—Six cc. intra-peritoneally.

Pig.—Seven cc. intra-peritoneally.

Calf.—Nine cc. intra-peritoneally.

In each series before inoculating the animals, a film of the emulsion was examined microscopically, and the first one was found to be swarming with parasites, so much so that it was impossible to count the number in a single film. The second emulsion was not so rich in parasites, there being about 100 to a field. All the animals used were YOUNG, and the monkey was the common *Macacus sinicus*.

For about fourteen days after the monkeys were inoculated no change was noted, except that they had slight fever. Later they began to show sign of emaciation, which was very evident in their hind legs, for when made to walk they had a tendency to fall; the wasting rapidly progressed. On June 2nd, MONKEY 1, was extremely weak, and could not stand on its legs. It lingered in this condition till July 5th when it died. An autopsy was immediately carried out. Its body was greatly emaciated all the skeletal muscles being markedly atrophied. The peritoneum appeared normal, and there were no evidences of inflammatory changes. The liver was slightly enlarged, but it did not have the characteristic mottled appearance always seen in human Kala Azar. The spleen was hard and shrunken, and weighed 2·5 gms.—a healthy spleen weighs from 3 to 5 gms. depending on the size of the animal—the kidneys were enlarged and pale on section, but the capsules were not adherent. There were no ulcers in any part of the intestinal tract, but there were one or two patches of congestion. The bone marrow was dark red, and appeared much more fluid than in the healthy condition. All the other organs including the brain appeared normal. Smears were made from the spleen, liver, and bone marrow, and on staining them and examining them extremely few parasites were found in the spleen, and fewer still in the liver and bone marrow.

Monkey 2 died late on the evening of July 14th, its body was placed in ice and examined next morning. It was emaciated to about the same extent as monkey 1. The spleen weighed 4·6 gms. and though only slightly enlarged was macroscopically typical of the disease; smears showed large numbers of the characteristic parasites, free as well as lying in large endothelial cells. The liver was much enlarged weighing 52·6 gms., and the mottled appearance was well seen. The smears from this organ contained many parasites. The bone marrow was red, and fluid, and in smear made from it, large numbers of parasites were seen. The intestinal tract was to all appearances normal except for a small patch of congestion in the jejunum. This monkey had diarrhœa a few days before death. The kidneys appeared swollen and pale, but no parasites were seen in smears made from them. There was nothing else to note in the case of the other organs.

Monkey 3 was chloroformed on July 16th, and an autopsy immediately carried out. It was also much emaciated, and could not have lived many days longer. The spleen was slightly enlarged, weighing 3·6 gms., and was typical of Kala Azar; smears showed many parasites. The liver was also enlarged, weighing 50·8 gms., the surface was mottled, but smears only showed a few parasites. The kidneys were similar to those of monkey 2. The bone marrow was red and fluid, and contained a large number of parasites.

Dog I. died on September 7th, and an autopsy was made shortly after death. The body was considerably wasted. Spleen weighed 10·8 gms., was slightly enlarged, and smears showed many parasites. The liver weighed 116 gms. was enlarged, and smears contained many parasites; the bone marrow was red and fluid, and contained numbers of parasites. All the lymphatic glands were slightly enlarged and smears made from them contained many parasites.

Dog III. died on September 26th, and a *post mortem* was carried out a few minutes after death. The body was much emaciated, the spleen was enlarged and weighed 17·5 gms.; the liver was also enlarged and weighed 140 gms. Both these organs however did not have the characteristic appearance of Kala Azar. The bone marrow was very red and fluid. Smears made from the spleen, liver, and bone marrow showed many parasites, particularly the marrow. It is interesting to note that this dog contracted *Piroplasma canis* a few days before it died, and in blood films of its peripheral blood taken a short time before death showed in addition to *Piroplasma canis* a number of Kala Azar parasites in the polymorphonuclear leucocytes. This experiment recalls some of those carried out by Basile but here we have a definite infection with *Piroplasma canis* complicating Kala Azar. I have already called attention to the possibility of this having taken place in Basile's experiments. Further it is important to note that in the films made from the organs of this dog, particularly the bone marrow and spleen it was very difficult to distinguish between phagocytosed forms of *Piroplasma canis* and those of *Herpetomonas donoani*. This dog had been four months in the experimental room, and every precaution had been

taken to exclude ticks, but it is quite evident that the precautions were not sufficient to prevent their access to the dogs. Those who have carried out experiments with *Piroplasma canis* in countries where ticks are numerous, and where almost every dog has had piroplasmosis will understand how even the most rigid precautions sometimes fail.

Jackal 1.—It was noticed that this animal was much emaciated, and had almost lost the power of its hind legs. It was decided to destroy it, and carry out a *post-mortem*, and this was done on July 31st. Beyond the emaciation there was nothing particular to note in any of the organs, the spleen if anything was smaller than is usual; the bone marrow was not much altered. Smears were made from all the organs and after an exhaustive search not a single parasite was found. The general condition of the animal certainly recalled Kala-Azar, but it is necessary to point out that another young jackal which was kept as a control, and which never had been inoculated died in much the same condition. I am well aware that several authorities go so far as to state that Kala-Azar may be so mild in some animals, that in order to prove the existence of the disease when the parasite cannot be found in smears it is important to make cultures from the organs. The control jackal, however, does away with any such objection, and I have no hesitation in saying that the animal did not die from unrecognised Kala-Azar.

White rat 4, as already recorded, died two hours after receiving the second inoculation on May 29th. Numerous parasites were found in its liver and spleen.

White rat 2 died on September 7th. No parasites or other indications of Kala-Azar was found on *post-mortem* examination.

In addition to the above experiments, the following were also carried out:—

Monkey 4 was inoculated subcutaneously on July 15th in the left flank with a drop of bone marrow taken *post-mortem* from monkey 2 (see above). This animal is still alive, and there is no lesion at the point of inoculation.

Monkey 5 was inoculated intra-peritoneally with 4cc. of heart blood of monkey 3 taken *post-mortem* on July 16th. This animal gradually emaciated, and frequently had rises of temperature which never exceeded 102·4°F. On September 17th it was noticed that the hind legs were dragging, and about September 20th it was unable to stand. It was destroyed on the 28th, and a *post-mortem* was immediately carried out by Dr. Korke. All the organs were found to be about normal, and the bone marrow though much diminished in quantity was of the usual white colour. No parasites could be found in any of the smears made from the organs. This is another instance of an animal dying with all the symptous of Kala-Azar, yet there was no proof that it had contracted the disease. I have long known that *M. sinicus* frequently dies in captivity of a condition which closely resembles experimental Kala-Azar. The animal slowly begins to emaciate, the hind limbs being the parts chiefly affected: "Drop foot" sets in and then later it drags the legs; the emaciation rapidly extends to the upper limbs, and the animal then can hardly move. It takes little or no food and soon dies. I have had the opportunity of examining many which have died in this condition, and except for the microscopical findings it closely simulates Kala-Azar. This condition developes after experimental inoculation of any kind, and I now have a young monkey which Captain Ingram inoculated with the parasite of infective granuloma; it is exactly in the same condition as the three monkeys which died of Kala-Azar. Further another monkey which was inoculated intra-peritoneally by Dr. Row with splenic blood removed by puncture from a case of Kala-Azar, in May 1910 developed the same condition about June 1912, and it was destroyed on July 16th. The *post-mortem* clearly showed that the animal had not developed Kala-Azar.

Monkey 6 was inoculated subcutaneously on July 16th with $\frac{1}{2}$ cc. of bone marrow from monkey 3. This animal is still alive, it has no local lesion and at present shows no signs of having developed Kala-Azar

Monkey 7 was inoculated subcutaneously with $\frac{1}{2}$ c.c. of bone marrow taken from monkey 3 on July 16th. It is still alive and well and has never had any local lesion.

Whiterat 5 inoculated with $\frac{1}{4}$ cc. intra-peritoneally (splenic puncture fluid from a human patient); it is still alive.

Whiterat 6, 7, 8 and 9. Two drops subcutaneously with splenic puncture fluid. No. 6 died on August 16th, No. 7 on September 9th, and No. 9 on September 16th, there were, however, no evidence that these rats had contracted Kala Azar.

Whiterat 10 was inoculated subcutaneously with two drops of bone marrow taken from monkey 2. It is still alive, its liver was punctured two months later, result negative.

Whiterat 11 was given a similar inoculation, and is still alive.

Whiterat 12 was inoculated intraperitoneally with 2 cc. of heart blood from monkey 3, and is still alive.

Whiterat 13 was inoculated subcutaneously with about $\frac{1}{2}$ cc. of liver puncture fluid from monkey 3, and is still alive.

Whiterat 14 was given a similar inoculation. Those inoculated subcutaneously have never developed a local lesion.

Dog 5 was inoculated intra-peritoneally with $\frac{1}{4}$ cc. of splenic puncture fluid from a case of Kala Azar on the 17th of March; it died on September 7th. At the *post-mortem* no evidences of Kala Azar were found, the bone marrow presented a normal appearance and the spleen was not enlarged.

In addition to the above experiments I have now examined dogs which were destroyed at the two lethal chambers of Madras. The majority of these animals came from the endemic area. They were typical street dogs, such as are common in large Eastern cities. In each case a large smear was made from the spleen immediately after the animal was destroyed, and this was examined later, but not a single animal was found infected. In many of the films there were structures closely simulating the parasite of Kala Azar, these were either artifacts or some stage of *Piroplasma canis* or *Piroplasma gibsoni*. It is important to note that in a large percentage of the dogs examined the spleen was found to be considerably enlarged, much more so than in the case of the two dogs which died of Kala Azar as noted above.

The following is a summary of the results obtained:—

Three monkeys inoculated with two enormous doses of splenic pulp contracted the disease and died.

Four monkeys inoculated with small doses have not up to the date (October) contracted the disease, one of these monkeys died as noted above, but not of Kala Azar.

Out of four dogs inoculated with two large doses of splenic pulp, two have died, while two are still alive and show at present no sign of the disease.

One dog inoculated more than six months ago with a small dose of splenic puncture fluid died, but not of Kala Azar.

Out of two jackals inoculated with large doses of splenic pulp, one died, but not of Kala Azar, the other is alive and well.

Two guinea pigs and two rabbits similarly inoculated are still quite healthy.

Two cats, a goat, pig, and a calf inoculated with large doses of Kala Azar material are still alive and well.

Out of four white rats inoculated with two large doses of splenic pulp, three are still alive and well, while one contracted the disease and died.

Out of ten white rats inoculated with small doses of Kala Azar material, three have died, but not of Kala Azar.

From these experiments I draw the following conclusions:—

1. The monkey, *Macacus sinicus* can be infected with the parasite of Madras Kala Azar only when inoculated with a large dose; it is possible that very young animals—a few weeks to four months old—may be more easily infected. Subcutaneous inoculation does not produce a local lesion simulating Oriental Sore. I have therefore not been able to confirm Dr. Row's observation who I presume was working with Madras Kala Azar.

2. The dog is to all intents totally refractory and can only be infected with large doses, and even then the experiment does not always succeed. Not a single street dog out of examined from the endemic area during the last seven months was found naturally infected. Kala Azar in Madras is therefore not of canine origin.

3. The jackal (*Canis indicus*) is similarly refractory, and can play no part in the transmission of the disease.

4. The domestic cat cannot be infected even with large repeated doses, and therefore Kala Azar in Madras is not of feline origin.

5. One white rat out of fourteen inoculated in various ways and with large doses died with parasites in its organs; it would appear that that it is not an easy matter infecting this animal. For all practical purposes it may be considered to be refractory. The parasite has, as far as I am aware, never been found in either *Mus rattus* or *Mus decumanus*; it is therefore difficult to understand how Kala-Azar in Madras can be of murine origin.

6. The rabbit and the guinea pig cannot be infected.

7. The goat, the calf, and the pig are also refractory, and can therefore have nothing to do with the origin of the disease in Madras.

8. As the monkey (*Macacus sinicus*) is not to be found in the streets of Madras, except perhaps here and there as a pet, it cannot possibly be concerned in the spread of the disease.

9. Though it is true only a few animals of each kind have been utilised, these have been given such gigantic doses; doses far exceeding anything the natural transmitting agent could possibly inoculate, that in my opinion the results may be taken as conclusive proof that the animals are for practical purposes refractory. Kala Azar in Madras is therefore not of animal origin.

10. These experiments clearly show that there is very little hope of transmitting Kala Azar to any animal by means of the bed bug (*Cimex rotundatus*).

FURTHER OBSERVATIONS ON THE DEVELOPMENT OF *HERPETOMONAS DONOVANI* IN *CIMEX ROTUNDATUS* AND *CIMEX LECTULARIUS*.

By Captain W. S. Patton, M.B. I.M.S., on Special Duty, Kala Azar enquiry.

In my last memoir on the development of *Herpetomonas donovani* in *Cimex rotundatus* and *Cimex lectularius*, I outlined several experiments, which I stated would be carried out at the first opportunity; these experiments were devised with the object of finding out the exact factors which govern the development of the parasite in the bug. One factor of considerable importance has already been discovered, namely that the parasites can only complete their development, when a sufficient interval is allowed for them to multiply, and pass on to their post-flagellate stage, and that, if the bug takes a feed of blood before this has been accomplished, the flagellates are destroyed. But before describing the present experiments, I think it will be useful to again draw attention to some points connected with this problem.

In the first place it is necessary to state, that the observations which have already been recorded by me, are based on the assumption that the parasite of Indian Kala Azar passes out of man's body by way of the peripheral blood, that it is ingested by some blood sucking insect, in which it becomes a flagellate, and that the insect transmits it to a healthy person, when it sucks his blood. I have never attempted to prove any other transmission hypothesis. In order to discover in which particular insect the parasite of Kala Azar undergoes its flagellate stage, it is necessary to feed all the likely insects on the peripheral blood of a case of Kala Azar, and then to dissect them, and search for the development of the parasite. What proof have we that a particular herpetomonas found in the midgut of a blood sucking insect, which has been fed on Kala Azar blood, *is* the developmental stage of the parasite? In order to answer this question, it is necessary for the observer to have an intimate knowledge of the flagellates of the insect in question. If however it is known, for certain, that the particular insect experimented with, is never infected with a natural herpetomonas, how is it still possible to be sure that a flagellate found in it has developed out of the parasite of Kala Azar? Fortunately in the case of this human parasite we have a valuable guide, and one which is not sufficiently realised. The parasite of Kala Azar, when ingested by an insect, is always in a white blood cell, and if a number of insects are examined at regular intervals after they have fed, the parasite should be found, first, lying unchanged in a leucocyte, and then later, when the leucocyte degenerates it is seen to be free, and then all its developmental changes can be observed. Here then we have an accurate guide, for there can be no possible doubt as to the origin of the herpetomonas encountered in the insect. This is a point of some importance, for even though the observer may not be acquainted with the herpetomonads of insects, if he pays particular attention to the fact mentioned above, he cannot possibly make a mistake regarding the true nature of such a parasite, found in an insect which has fed on the peripheral blood of a case of Kala Azar. Now in all my papers on the development of the parasite in the bed bug, I have carefully described it, first in its unchanged condition in a leucocyte, its becoming free as the leucocyte is digested, and its subsequent development into a flagellate. Were the bug or any other insect, fed on cultures of the parasite, it would *not* be possible to distinguish between a natural herpetomonas of the insects, and the flagellate stage of the parasite of Kala Azar.

Having found that the parasite *only* develops into a flagellate in the bug, are we justified in concluding that *this* insect is the true invertebrate host of the parasite, and that it transmits it to man? In order to answer the above question it is necessary to consider some points in connection with the development of the parasite in the bed bug. There can be no doubt that there always is some relation between the digestion of the blood in an insect, and the various stages

in the life history of a parasite it may ingest in the blood. I believe that herein lies the clue to some of the mysteries surrounding the transmission of protozoa by blood sucking insects. In considering the extra-corporeal life history of the parasite of Kala Azar, it should be remembered that we are dealing with a protozoon, which can only enter the midgut of its invertebrate host in a non-motile stage, and its power to maintain itself, depends on whether it is able to pass on to its motile form; further when this stage is reached, it is necessary that it should be able to multiply. In the case of a protozoon like *Trypanosoma gambiense,* on the other hand, we are dealing with a flagellate, which when it enters the midgut of its invertebrate host, *Glossina palpalis*, is already motile, yet we know that it can only maintain itself and multiply in about 5 per cent. of the flies which ingest it. Why is it that in only about five flies out of every hundred, this parasite can live, multiply, and complete its development, and render the fly infective? The answer to this question will I believe be found by studying the digestive processes in the fly, and their relation to the life history of *T. gambiense.* It will be of interest to consider some of the factors which might bear on this point.

Sterility of the alimentary tract of the invertebrate host of a flagellate is of the first importance, for it is well known that these parasites cannot live in any medium, which is infected with bacteria. The bacteria themselves require food, and their presence must reduce the amount available for the flagellates. Further, it is very probable they produce toxic substances, which affect not only the blood as it is being digested, but destroy the flagellates. It is true, certain insect herpetomonads may be found associated with bacteria, for instance *Herpetomonas muscae domesticae* in *Musca nebulo.* In this case however, I have found when dealing with flies bred and infected in the laboratory that those which swarm with bacteria never contained flagellates, but when they were rich in flagellates there were never many bacteria. In flies caught at large however, there were often some bacteria as well as the flagellates in the midgut of the fly, but, as a rule, they never appeared to completely invade its alimentary tract. The post-flagellate stage of *Herpetomonas muscae domesticae* in the hindgut of the fly is frequently associated with bacteria, here however we are dealing with a stage on which bacteria can have little or no injurious effect. In most blood sucking insects, under natural conditions, bacteria are rarely found; they are not common in the bed bug. In the case of the parasite of Kala Azar, bacteria are very injurious, for when they are present it not only fails to develop into a flagellate, but the flagellates readily die out. The presence or absence of bacteria in the alimentary tract of the invertebrate host of this parasite must then have a direct bearing on its life history. In addition to bacteria, fungi and yeasts may also invade the alimentary tracts of blood sucking insects, and we know that they destroy these parasites. Miss Porter has very clearly shewn the effect of a fungus on *Crithidia melophagia,* Flu; she points out that fungus infected keds (*Melophagus ovinus*) are widely distributed, and that this organism is most usually found in the malpighian tubes of the ked. When infected with the fungus, keds, rarely if ever, contained *Crithidia melophagia,* the fungus having a distinct pathogenic action on the flagellate. In order therefore for the parasite of Kala Azar to pass from its pre-flagellate to its flagellate stage, it is essential for the alimentary tract of its invertebrate host to be sterile.

The factor which has the most important bearing on the life processes of the parasite of Kala Azar is the temperature at which its insect host is, at the time the parasite is ingested; this of course assumes that all insects are always the same temperature as their surroundings. On examining bugs which have been kept at a high temperature, and on comparing the digestion of blood in them, with that in bugs kept at a relatively low temperature, it will be found that digestion is markedly retarded in the latter. The blood ingested by bugs kept at a temperature varying from 80°F. to 90°F. is broken up in from six to eight hours, the red cells, becoming unrecognisable as such, while the leucocytes have become disintegrated. The blood in bugs kept at a temperature varying from 60°F. to 80°F. remains more or less unchanged, for from twentyfour to ninety-six hours or longer; the lower the temperature the longer the red cells and

leucocytes remain unchanged. In bugs kept from 50°F. to 60°F. the leucocytes can be recognised even on the tenth day after they were ingested. In this connection it should be remembered that the parasite of Kala Azar can only develop into a flagellate, when it has been completely freed from the leucocyte in which it lies, it is however true that development always begins before the leucocyte has changed much. It will then be understood that the longer the leucocyte remains intact, the longer must the parasite remain a pre-flagellate.

I have now described some of the main points connected with this problem, and it will be seen that I have confined my observations to the discovery of the invertebrate host of the parasite, and as to how it then transmits it to man. I have so far been successful, in that I have found that the parasite only flagellates in the bed bug, and that it does not undergo this change in any other insect I have experimented with. I have further found, that the development in the bug depends on two very definite factors. One I have already recorded, namely, that the flagellate stage of the parasite is destroyed in the bug if that insect takes a feed of blood while the parasite is still in that stage. The other factor is the temperature at which the bug is at the time the parasite is ingested. I have now been able to carry out a series of experiments in order to find out the exact range of temperature best suited for the development, and I propose describing these observations in the present paper. These observations have clearly shewn that there is a very narrow limit of temperature in which the parasite can multiply in the bug. In my opinion this factor is of the first importance in explaining some of the peculiarities connected with the geographical distribution and spread of Kala Azar in India. I believe that the discovery of these two factors is sufficient evidence to shew that the development in the bug is not merely accidental, but that this insect is the true invertebrate host of the parasite. The temperature of the bug—which is that of the air surrounding it—affects the life history of the parasite in that it directly acts on the digestion of the blood; this cannot be due to mere accident but has resulted from the altered habits of the bug from once being a plant feeder to its present condition. That the parasite of Kala Azar is closely related to all the species of insect herpetomonads there can be no doubt, and we can only assume that it once lived entirely in the alimentary tract of some insect. A study of these insect herpetomonads reveals the fact that the majority are truly specific in that they only live in one insect, or species closely related to it. It is true there are some who believe this is not the case, but at present there is no proof to support the view that herpetomonads occurring in widely separated insects are one and the same species; this can only be proved by carrying out cross transmission experiments by trying to infect bred insects with herpetomonads peculiar to others. That a herpetomonad from one insect is very like that from another, is no proof of their identity. Knowing that the parasite of Kala Azar, as far as I have been able to find out, only undergoes its flagellate stage in one blood sucking insect, and that there are, at least, two very definite factors which govern its development in that insect, I feel justified in concluding that the bed bug is the true invertebrate host of this human parasite, and that it transmits it to man by its bite; and this is in spite of the fact that the parasite has not, up to the present, actually been transmitted to an animal by the bug. The discovery of these two factors further goes to shew that it would be futile to attempt to transmit the parasite by feeding infected bugs on a susceptible animal, until all the points connected with its life history are known. Let us suppose it was found that a certain animal was extremely susceptible to the parasite, and bugs which had previously been fed on a patient with many parasites in his circulating blood, were allowed to feed on it. If it was not known that fresh blood, even from a monkey, destroys the flagellates in the bug the experiments would most certainly fail; exactly the same thing would happen if the bugs were utilised in the hot weather in Madras, as I will point out further on. I therefore do not see any object in carrying out such experiments until everything has been found out in connection with the development and multiplication of the parasite in the bug. In order to finally prove that the bug is the actual transmitter of the parasite to man, I believe it is of the first importance to work out its complete life history, and to ascertain all the factors which effect its life processes. This can only be accomplished by prolonged

observations and accurate feeding experiments under all possible conditions. I am convinced this is the shortest way to the solution of this problem, and therefore I do not propose deviating from the course I have followed now for several years. When all the factors have been ascertained, transmission experiments will at once be carried out.

What temperature is best suited for the development of the parasite in the bed bug.

Apart from the scientific interest attached to the result of this experiment, it has a practical bearing in connection with the spread of the disease in India, and the answer to this question will undoubtedly give us a clue to the curious localised distribution of Kala Azar. Much importance has in the past been attached to the idea that this disease clings to low-lying damp localities. I believe it will yet be found that the dampness of an infected locality has little or nothing to do with the localisation of the disease, but that its peculiar distribution has to do with a totally different set of factors, one of which is just the right temperature for the development of the parasite in the bed bug. I have now carried out a long series of experiments in order to answer the above question. A large number of bugs of both species were fed on a case in the General Hospital, Madras, in a film of whose peripheral blood there were never more than 20 to 30 parasites. Half the bugs were kept at room temperature in my laboratory, and the other half in the cold room of this Institute. The room temperature while the experiments were being carried out, varied from 86°F. to 90°F.; the temperature in the cold room varied from 55°F. to 65°F., and for very short periods went up to 67°F. In each case the bugs were only fed once on the patient. They were dissected on the seventh, eighth, and ninth days after their single feed. In the majority of those kept at room temperature, not a single parasite could be found on these days, but in a few, one or two unchanged parasites were seen as late as the fifth day. In the bugs which were kept in the cold room, six were found to contain from four to twelve unchanged parasites as late as the ninth day. In the films made from the midgut contents of these bugs it was noted, that even as late as the ninth day, the leucocytes could be recognised, though they had undoubtedly undergone considerable disintegration.

It was also noticed that the leucocytes were packed with granules of blood pigment. This observation is of considerable interest, for it shews that, although the red blood cells had broken up and disappeared, the white cells had remained alive for several days, and during this time were actively ingesting the blood pigment which is commonly found in the stomach of the bug. The fact that the leucocytes, both mononuclear, and polymorphonuclear, remained alive, and active, can only mean that the digestive processes in the bug were partially arrested at the temperature at which they were kept; although the red cells had been digested, the leucocytes were able to carry on their phagocitic activities.

Shortly after the above experiments had been completed, I had the opportunity of carrying out another series on a case of Kala Azar which was remarkable in several ways, so that, before recording the experiments, it will be important to describe this case.

Chinappa, a cooly boy, aged 12, was admitted for the second time into the General Hospital on March 3rd, 1912, suffering from broncho-pneumonia, complicating Kala Azar. His temperature on admission was 104·6°F., and he had all the clinical signs of the above lung condition. His was a typical case of Kala Azar, and according to his own statement he had been ill for two years with fever and oedema. He was considerably emaciated, his legs were oedematous, his skin harsh and in parts pigmented. His spleen extended four finger breadth below the costal arch, and two fingers from the umbilicus; his liver extended two finger breadths below the costal arch. He had considerable pain on palpation

over the ascending colon, suggesting a previous attack of colitis. He was markedly anaemic. Parasites were found in the first blood film I examined, and it was then noted that there was a considerable leucocytosis (polymorphonuclear). He slowly recovered from the attack of pneumonia, and then remained in a stationary condition for about two months. During this time his blood was examined at frequent intervals, and parasites were always found, and the leucocytosis persisted, though to a diminished extent. Bugs and fleas were fed on him on many occasions. On May 23rd it was noticed that the boy's temperature was higher than usual (103°F.), and that he had a cough with some expectoration, and that his respiration was rapid. A blood film was taken, and on examining it, three Kala Azar parasites were found, and in addition many young merozoits of the parasite of benign tertian malaria; in the evening his temperature rose to 104° F., and he appeared to be very ill.

His blood was examined again on the 24th, and in addition to a few malarial parasites, over 500 Kala Azar parasites were counted in one blood film; in a film taken the same evening 1,043 Kala Azar bodies were counted. Films taken on the 25th each contained over 900 parasites, those taken on the 26th contained between 700 and 800, on the 27th between 500 and 600, on the 28th between 400 and 500, and a film taken just before he died contained between 200 and 300. A careful clinical examination on the 24th and 25th at once revealed the fact that he now had lobar pneumonia, and that the whole of his right lung was solid; his sputum was blood stained and characteristic of the pneumonic condition. Judging from his general condition on the 28th, there appeared to be every hope of his recovery, he however, suddenly collapsed on the morning of the 29th and died in about an hour. A *post mortem* was immediately carried out, and in addition to the solid right lung, a large empyema was found situated on the anterior surface of the upper lobe, six inches in length, and four inches in breadth; the pleura was firmly adherent to the chest wall, and the pus was of a thick glutinous character. There was nothing particular to note about the other organs, except that the large intestine was not at the time ulcerated. This case was remarkable in several ways, for although I have during the last five years seen over a hundred cases of Kala Azar, and examined several thousands of films of finger blood, I have never seen so many parasites. It will be remembered that I, long ago, pointed out that there are certain occasions in this disease when a large number of parasites can be found in films of finger blood, and that these occasions were chiefly characterised by very severe dysenteric symptoms. I wish however to correct the erroneous statement which has been attributed to me, that it is only when a patient is *in articulo mortis* as a result of dysentery, that the parasites become numerous in the peripheral blood; I have nowhere made any such statement. The number of parasites in the circulating blood has nothing to do with the approach of death, on the contrary, they are always fewer at this time. When this condition was first noted, I attributed the great increase in the number of the parasites to a fresh focus of infection in the intestinal tract. In the case described above there was no fresh focus of infection anywhere as far as could be discovered. Careful smears were made from the pneumonic lung, as well as from the pus, but I was unable to find anything to suggest that the parasites found in the lung smears were other than those in the circulating blood. It is therefore clear that the great increase in the number of parasites in the peripheral blood, was in some way connected with the presence of a large cavity containing pus, and which was accompanied with an enormous leucocytosis (polymorphonuclear), and that this reaction had probably caused the parasites to multiply in the spleen, and possibly elsewhere. These parasites on being freed from the large endothelial cells were at once phygocytosed, and then appeared in the circulating blood. In support of this explanation there are the following facts:—A large number of the parasites seen in the films were in polymorphonuclear leucocytes in which they were actively dividing. In many of the leucocytes the parasites were grouped together in a characteristic manner, and they were evidently lying in the remains of the protoplasm of the large endothelial cells, when they were taken up by the leucocytes.

This appearance, I have only seen in the peripheral blood of those cases with severe dysentery, when there is a sudden marked rise in the number of the parasites in the circulating blood. Lastly it was noted in another case which

died in the hospital shortly after the above case that about five days before death there was a sudden rise in the number of parasites in films of finger blood. At the time this patient had the early stage of cancrum oris, but although I have had the opportunity of examining the blood of many cases with this complication, I have never noted any marked increase in the number of parasites in the films of finger blood. The patient died somewhat suddenly, but I had noticed that he was in a very drowsy, semi-comatose condition; at the *post mortem* Dr. Korke told me he found the right kidney was practically a bag of pus.

It would then appear that the rise in the number of the parasites in the circulating blood in those cases of severe dysentery is not due to a fresh focus of infection but rather to the presence of extensive ulceration and resulting leucocytosis.

Another point of interest attaching to the case of the boy, Chinappa, was the association of one of the parasites of malaria with that of Kala Azar. This is the first occasion I have found the two parasites together, and Colonel Robertson, I.M.S., informs me he has only seen the two parasites together in a single case; this is certainly very remarkable, for malaria is common enough in George Town, the home of Kala Azar. That malaria is on the increase in Madras I have no doubt, for recently I have seen a number of cases of true chronic malaria closely simulating Kala Azar; in former years this was unusual. I can offer no explanation of why the two parasites are not more frequently seen together; it may perhaps be that they are inimical to each other.

As soon as I found that the blood of the boy mentioned above was swarming with *Herpetomonas Donovani*, I fed a large number of bugs of both species on him, and hoped to settle all the remaining points connected with the exact method of transmission of the parasite by the bug. It will however be seen later, that a new factor in connection with the life history of the parasite was discovered, and though the results were most disappointing, I have been able to still further narrow down the problem. In addition to finding out all the points connected with the life history of the parasite, I aimed at determining as near as possible the temperature conditions connected with its development.

The bugs were therefore divided into batches, and were kept under the following conditions :—

1. A large number were placed in my laboratory in a cupboard, and kept at room temperature. They were not crowded together in small tubes, but were placed on pieces of filter paper in large glass jars. The temperature of the laboratory was recorded on a thermograph, and from May 24th to May the 31st, the average minimum temperature was 85°F., and the average maximum 94°F.; the bugs used for this observation were fed on the 24th and 26th.

2. Another batch were kept in similar jars in a Hearson's cold incubator at a temperature varying from 75°F. to 80°F.

3. A third batch were kept in another cold incubator at a temperature varying from 73°F. to 75°F. I had hoped to maintain the temperature of this incubator from 70°F. to 72°F., but just at this time the temperature of Madras was at its highest, and the maximum on several of the days being well over 100°F., and on one day 112°F. Under these conditions it was found impossible to keep the temperature of this incubator lower, although large quantities of ice were used.

4. The fourth batch of bugs was kept in one of the cold rooms of the Institute, the temperature of which varied from 55°F. to 65°F.

It will be seen from the above that range of a very wide temperature was utilised.

Examination of bugs kept at room temperature, 85°F. to 94°F.—The bugs used in this experiment were dissected, as I have already described in a previous

report, the midgut and its contents were smeared out on one part of the slide, and the hindgut and its contents on another part.

Bug No. 1.—Dissected 40 hours after being fed on the case, which was on the day when about 500 parasites were seen in films of finger blood. Its midgut contained much digested blood, the red cells and leucocytes had all disappeared. Many parasites were seen free, some were obviously disintegrating as evidenced by the way they stained; it was also clear that many had already disappeared. A few were enlarged, and shewed the characteristic blue staining protoplasm, as is seen in young developing forms, but only a few were in the stage preceding the extrusion of the flagellum. Several were elongated and lying in pairs, and had very faintly-staining flagella. There were several long thin flagellates, with well developed flagella. No parasites of any kind were seen in the smear made from the hindgut.

Bug No. 2.—Fed on the same day as No. 1 and dissected 44 hours after its feed. The midgut film contained fewer parasites than that of No. 1. Most were unchanged, a few shewed the typical appearance of the formation of the flagellum, which I have several times described; several flagellates were seen. Two degenerating leucocytes containing parasites were found.

Bug No. 5.—Fed on the same day as No. 1, and dissected 48 hours after its feed; the midgut contained a large amount of digested blood, but no leucocytes were seen. There were a few unchanged parasites lying free, and six degenerating ones were found grouped together. There were no flagellates, and the hindgut smear did not shew a parasite of any kind.

Bug No. 15.—Fed on the same day as No. 1, and dissected 70 hours later. After a long search a few unchanged free parasites were found, two were slightly enlarged. There were no flagellates, and no enlarged parasites shewing the characteristic changes just prior to the extrusion of the flagellum. No parasites were seen in the hindgut smear.

Bug No. 16.—Fed on the 26th at 10 A. M., and dissected 19 hours later. Its midgut contained a fair quantity of digested blood. There were many parasites all free, several were much enlarged and shewed the early and late stage in the formation of the flagellum. Quite a number were elongated and lying in pairs, and had evidently divided, without flagellating. A few long thin flagellates and some short forms were found. There were also some degenerating long forms probably flagellates.

Bug No. 29.—Fed at the same time as No. 1, and dissected 34 hours later. The blood was almost all digested and the midgut nearly empty. Not a single parasite was found.

Bug No. 30.—Fed at the same time as No. 1, and dissected 136 hours later. The midgut contained a small quantity of blood, but the smear did not contain any parasites.

The remaining bugs were fed on a white rat, and dissected later but nothing was found in any of them. As a result of this experiment it will be seen that the parasite will flagellate in the bug at a high temperature, confirming the observations made by me in 1906. From a reference to the figures in my first report, it will be observed that I then obtained very similar results, but with this difference that the bugs were fed several times, and I was not then able to say how long the parasite remained alive in its alimentary tract. These recent experiments have however conclusively proved that though the parasites will develop into flagellates in the bug during the hot weather in Madras, they disappear by the fifth and sixth days. The bugs used in this last experiment were fed by myself and two assistants, and we sat for nearly an hour till every bug had taken a complete feed, those which had not fed were removed and destroyed. There was then no doubt whatever that all the bugs had ingested several hundred parasites. I therefore consider this experiment conclusive proof that the bug can never transmit the Kala Azar parasite during the hot weather in Madras; this at least is some consolation to those who are in constant dread of contreating this fatal disease.

Examination of bugs kept at a temperature varying from 75°F. to 80°F.

Bug No. 4.—Fed on the 24th at 5 P. M., and dissected 46 hours later. The midgut contained much blood, and the stained smear shewed unchanged red cells and leucocytes. There were numerous parasites in the white cells, and many free, these being in the early stages of development; several shewed the division of the flagellum, and the growth of the flagellar myoneme very clearly. There were also several young flagellates.

Bug No. 8.—Fed on May 25th at 5 P. M., and dissected 39 hours later. The midgut contained a large quantity of partly digested blood, the red cells could still be recognised, and most of the leucocytes were unchanged. The smear shewed many parasites, mostly in the early stages of development while still in the white cells, a fair number were free. There were a few young flagellates.

Bug No. 9.—Fed at the same time as No. 8, and dissected 42 hours later. There were many unchanged red cells and leucocytes, many of the latter had degenerated and the parasites they contained were well advanced towards flagellation. There were many young and mature flagellates. The digestion of the blood in this bug had proceeded more rapidly than in the case of No. 8.

Bug No. 25.—Fed on the 24th at 5 P. M., and dissected 96 hours later. The midgut contained only a small quantity of blood, as digestion had been completed; there were no unchanged leucocytes. Only a few unchanged and degenerating parasites were seen, but there were no flagellates.

Bug No. 26.—Fed at the same time as No. 25, and dissected just after it. The blood was completely digested and there were no parasites.

Bug No. 35.—Fed on the 24th and dissected 149 hours later. The midgut contained much digested blood chiefly regurgitated from the hindgut. No parasites could be found in the smear. I have frequently noticed while dissecting bugs when the midgut was dissected out and the hindgut was still in the abdomen that a large quantity of the contents of the latter was driven into the midgut. I have noticed this happen even before the midgut was dissected out, for it can be seen through the chitinous integument; when a bug's midgut is empty, it always contains air and it can thus be clearly recognised. As the contents of the hindgut are shot into the midgut, active peristalsis can be observed in the latter, and the contained air can be seen moving about.

The remaining bugs which were used for this experiment were dissected on the fifth, sixth and seventh days after their feed, but with negative results. This experiment then clearly shews that a temperature varying from 75°F. to 80°F. is unsuitable for the development and multiplication of the parasite, and that though it flagellates, it never multiplies but dies out about the fifth day.

Examination of bugs kept at a temperature varying from 73°F. to 75°F.

Bug No. 3.—Fed on the 24th, and dissected 45 hours later. The stained smear shewed some red cells and leucocytes, but the digestion of the blood was considerably advanced. Most of the parasites were free, and shewed the early changes towards development; there were also a few young flagellates.

Bug No. 6.—Fed on the 25th and found dead on the 26th, dissected 31 hours after its feed. The midgut smear was found to be swarming with colon-like bacilli; there were a few parasites, and some of these were about to flagellate.

Bug No. 7.—Fed on the 25th and dissected 32 hours later. Digestion was fairly well advanced, most of the leucocytes were degenerating, and the parasites they contained were all shewing the early and late changes preceding flagellation. There were a large number of such forms, but no flagellates.

Bug No. 10.—Fed on the 24th at 5 P.M., and dissected 63 hours later. The blood in the midgut was completely digested, there were many unchanged parasites and some young flagellates. A few shewed the stage preceding the extrusion of the flagellum.

Bug No. 11.—Fed on the 25th at 10 A.M., and dissected 44 hours later. The midgut contained much semi-digested blood. There were many preflagellates in all stages of development lying free, as well as in leucocytes; and there were also some young flagellates.

Bug No. 12.—Fed at the same time as No. 11, and dissected 45 hours later; there was much partially digested blood in the midgut. There were many free parasites shewing the early and late stages preceding the extrusion of the flagellum, and a few young flagellates were seen. It was noted that the digestion of the blood was more advanced than in No. 11.

Bug No. 13.—Fed at the same time as No. 11, and dissected 46 hours after its feed. The midgut was full of semi-digested blood. The parasites were in the same condition as in the two previous bugs.

Bug No. 14.—Fed at the same time as No. 11, and dissected 47 hours after its feed. The blood in the midgut was almost completely digested; there were many unchanged parasites, a few shewing development, but no flagellates. The most striking fact regarding the parasites in these bugs was that they were clearly not developing and multiplying as was the case in the bugs recorded in my last paper. There were no evidences of multiple segmentation either in the pre-flagellate or the flagellate stage; this is a point of considerable importance.

Bug No. 17.—Fed on the 24th at 5 P.M., and dissected 70 hours later. The blood in the midgut was almost completely digested. There were a few unchanged parasites as well as some shewing the early changes towards flagellation; several degenerating parasites were found and the nuclei and blepharoplaste of many were all that was left of them. There were a few short, and two long flagellates.

Bug No. 18.—Fed on the same day as No. 17, and dissected 71 hours after its feed. The blood in the midgut was completely digested. There were a few unchanged parasites as well as one or two shewing the early appearances of development; two short flagellates were also seen.

Bug No. 19.—Fed on the 25th at 10 A.M., and dissected 72 hours later. The blood in the midgut was completely digested. Four unchanged parasites were seen and several degenerating flagellates and preflagellates, but most of the parasites had obviously disappeared.

Bug No. 20.—Fed on the same day as No. 19, and dissected 73 hours after its feed. The midgut contained digested blood exactly similar to what is seen in the hindgut of the bug. Five apparently unchanged parasites were found after a long search; but there were no flagellates or young developing forms.

Bug No. 21.—Fed on the same day as No. 19, and dissected 76 hours after its feed. The midgut contained the same fluid as was seen in No. 20. The smear contained several unchanged parasites, others in various stages of development, and many groups of young flagellates which were well stained. In addition there were several degenerating and degenerated flagellates. This bug contained the best developed forms, but it was evident from the degeneration taking place in some of the flagellates, that the others would not have lived much longer.

Bug No. 22.—Fed on the same day as No. 19, and dissected 77 hours after its feed. The midgut contained a small quantity of digested blood. There were only a few unchanged parasites, and no flagellates.

Bug No. 27.—Fed on the same day as No. 19, and dissected 101 hours after its feed. The midgut contained much digested blood, and the smear shewed a very few unchanged and degenerating parasites.

Bug No. 28.—Fed on the same day as No. 19, and dissected 102 hours after its feed. The midgut contained some digested blood and many air bubbes and the smear only shewed four unchanged parasites, which were found after a long search.

Bug No. 32.—Fed on the 26th and dissected 100 hours after its feed. The midgut contained much digested blood, similar to that seen in the hindgut. Only a few unchanged parasites could be found.

Bug No. 33.—Fed on the same day as No. 32, and dissected 103 hours after its feed. The midgut contained a lot of digested blood, and in the smear a few unchanged parasites, and some degenerating forms were seen.

Bug No. 34.—Fed on the same day as No. 32, and dissected 104 hours after its feed. The midgut contained much black digested blood, but not a single parasite of any kind could be found

The remaining bugs, some 20 in number, were dissected from the fifth to the eighth day after their feed, but with negative results. It was therefore clear that the temperature at which the bugs were kept was unsuitable for the development and multiplication of the parasites.

Examination of bugs kept at a temperature varying from 55°F. to 65°F.

Bug No. 23.—Fed on the case on the 24th at 5 P.M., and dissected 93 hours later. The midgut contained a large quantity of reddish blood only partly digested, many leucocytes and red cells being quite unaltered. There were a large number of unchanged parasites still lying in leucocytes (polymorphonuclear), as well as many free forms; many clearly shewed all the early changes towards development, but there were no flagellates.

Bug No. 24.—Fed at the same time as No. 23, and dissected 96 hours after its feed. The midgut contained a large quantity of red blood, the same as No. 23, and the parasites were also in the same condition. Twenty-four bugs which had been kept in the cold room were dissected from the fifth to the tenth day after their feed; they contained unchanged parasites, a few developing forms, and in each several flagellates were seen, but it was obvious that the development was so retarded by the low temperature that they failed to develop normally and multiply after flagellating. Unchanged parasites were seen in several other bugs as late as the twelfth and thirteenth days, but after this, not a single parasite could be found.

The observations recorded above, confirm the previous ones and prove that if the bug is kept at a low temperature the parasite of Indian Kala Azar fails to develop and multiply normally in its alimentary tract, and disappears after the tenth or twelfth day. Knowing that every bug used in these experiments must have ingested at least 100 parasites it is clear that *Herpetomonas donovani* is unable to complete its life-history at the various temperatures utilised. What then is the exact temperature necessary for its complete development? It will be remembered that in my last experiments in which I was able to follow the life-history of the parasite up to its post-flagellate stage, the bugs were kept in a cold incubator; a careful record of the temperature of the incubator was however not kept, but it was then stated to have been about 71°F. to 75°F. (22°C to 24°C). These experiments were carried out during the last days of January and the first week of February 1912. The mean temperature of Madras for the 24 hours during this time of the year is about 72°F. to 75°F., the minimum may go down as low as 62°F. and the maximum as high as 85°F. It will therefore be seen that the temperature the bugs were then kept at, was practically that of the temperature of an inside room in Madras. From this I am led to infer that there is a very narrow limit of temperature within which the parasite can flagellate, multiply, and complete its development in the bug. When is this temperature attained in Madras? In order to answer this question I have collected the temperature records of the City of Madras for the last ten years, and without going into the details, I find that the necessary range of temperature is to be

found in the months of December, January, and the first half of February. Here are the figures :—

		Average Maximum.	Average Minimum.	Average Mean.
	January	86·6	70	77·3
1901	December	82·6	68·9	75·6
	January	83·8	67·5	75·8
1902	December	82·9	72·1	77·6
	January	84	69·8	77
1903	December	82	69·7	75·9
	January	83·1	69·2	76·2
1904	December	83·7	69·6	76·5
	January	83·2	65·2	74·2
1905	December	83·5	67·8	75·4
	January	83·9	69·6	76·8
1906	December	81·6	71·5	76·6
	January	83·9	66·8	75·4
1907	December	82·9	69·4	76·2
	January	84·4	68·3	76·4
1908	December	82·7	68·6	75·6
	January	83·6	67·9	75·8
1909	December	85·6	71	78·3
	January	86·3	67·6	76·7
1910	December	83·7	66·9	75·7
	January	85·8	67·8	77·1
1911	December	82·5	71·4	77·5

It is interesting to refer to the feeding experiments recorded in my second memoir on the development of the parasite in the bug. The twelve bugs were fed on the case on December 27th 1906, and the last bug was dissected on January 2nd 1907, and from the above table of temperatures, it will be seen that the average mean temperatures of the two months was 76·6°F. and 75·4°F. respectively ; the bugs in this case were kept in an open verandah on a table. In all these bugs there was a rapid and normal development, suggesting that the life-history of the parasite would have been completed in another five or six days.

From the above more recent observations the following conclusions can be drawn :—

1. The parasite of Indian Kala Azar will flagellate in the bug at a high temperature, but instead of multiplying, it dies out and disappears in about five days after it is ingested.
2. The parasite will also flagellate in the bug at a low temperature and though it persists in the insect for about twelve days after it is ingested, it never multiplies to any extent, but dies out.
3. The parasite flagellates and persists for a few days in bugs kept at a temperature varying from 73°F. to 80°F., but here again it never multiplies but dies out.

4. The temperature corresponding to that of the months of December and January in Madras appears to be the most suitable for its development in the bug; it is then able to pass on to its post-flagellate stage. It is I think a very striking fact to note that the parasite of Oriental Sore in Cambay behaves in a still more peculiar way, in that it will only flagellate in the bug below a temperature of about 75°F. The parasite of Kala Azar on the other hand will flagellate in the bug at a high temperature but fails to multiply, and soon disappears. I am confident that these peculiarities in the life-histories of these two parasites are not accidental but that they give us some insight into their origin, and further explain why the two diseases they produce are never found, so far as we know at present, side by side in India. The temperature and the resulting effect it has on the digestion of the blood in the bug, is the factor of the first importance which governs their life histories, and in each case the range is different and at the same time very limited. I hope in the coming cold weather in Madras to settle the problem regarding the exact temperature, and at the same time to find out the importance or otherwise of one more factor connected with the life-history of the parasite, which I have for some time had in view, and which I will refer to on another occasion. Until all this has been solved by feeding experiments and dissections, I do not propose carrying out any transmission experiments with infected bugs; such experiments would be conducted with imperfect knowledge, and would surely lead to failure.

Progress Report on Kala Azar

By Captain F. P. Mackie, I.M.S.

After leaving Madras early in May 1912 I was ordered to go to Cooch Behar State and examine the site of an epidemic area.

This occupied me from May 11th to May 19th and a report of my findings was forwarded to the President, Kala Azar Investigation Committee, on May 18th, 1912.

I then went direct to Shillong, May 30th, and remained till July 17th.

I occupied my time there by studying the records and files relating to the distribution of Kala Azar to which I was given access by the Sanitary Commissioner and the Deputy Sanitary Commissioner.

I had an interview with the Chief Commissioner on the subject and conferred with him and with the abovementioned Sanitary officials in reference to a scheme for the investigation of Kala Azar in Assam.

This scheme is being dealt with by Captain Mc'Combie Young, I.M.S., Deputy Sanitary Commissioner for Assam, at the present Conference.

These duties having been completed and there being no possibility of touring the infected areas at that season of the year, I returned to Calcutta on July 20th where I was joined by Sub-Assistant Surgeon Jamiatram and a flyman.

I visited the principal hospitals daily in search of Kala Azar cases ; but though every assistance was given to me by the Physicians in charge, I had only been able to find about four or five cases at the end of three weeks, and as the main project I had in view, namely, the transmission of the disease to animals, seemed likely to be delayed inordinately I left Calcutta for Kalna, Burdwan district, on August 15th, 1912.

I was attracted here by a paper in the " I.M.G., February 1911, pages 58–60 " by Dr. Muir, the head of the Mission Hospital, in which he stated that he saw six or seven hundred cases of Kala Azar in a week. He believes now the number to be very much overestimated and in this I agree with him.

By a successful and popular treatment for enlarged spleen Dr. Muir has attracted large number of such cases to his dispensary, and since I have been here there have been certainly four or five hundred cases of enlarged spleen a week passing through the dispensary.

Relative frequency of Kala Azar to other causes of splenic enlargement.

This was the first point to settle; and large numbers of out-patients were passed in review and any that were considered clinically suspicious of Kala Azar were subjected to spleen puncture.

In the two months this work has been carried on (the hospital was practically closed in the pujas), 58 cases of suspected Kala Azar were punctured and 23 (39·6 per cent.) showed the presence of *Leishmania Donovani*, while 35 (60·4 per cent.) were negative.

It was evident then that the very large majority of the total unselected cases were malarial splenegamy or at any rate were not Kala Azar.

At this point I took a spleen census amongst the scholars of four schools in Kalna, and in a total of 236 children I found the following distribution :—

Ages.	Enlarged spleen.	Spleens not enlarged.	Total.	Percentage of enlarged spleen.
1 to 5 years	7	15	22	31·8
5 to 10 ,, ...	19	66	85	22·3
10 to 15 ,, ...	22	74	96	23·0
15 to 20 ,, ...	7	26	33	21·2
Total	55	181	236	23·2

If the "spleen rate" is disturbed amongst these children by Kala Azar, I think it is to a very slight degree, as all these children seemed in good health and none were suspicious of Kala Azar on clinical grounds.

The prevailing types of anopheles are *N. Rossii* and *N. Fuliginosis.*

Clinical and Epidemological Features of Kala Azar in the Burdwan District.

Out of the 23 cases diagnosed by spleen puncture the age distribution was—

Under 10 years	*Nil.*
Between 10–20 years.	12
,, 20–30 ,, ...	8
Over 30 ,, ...	3

The absence of the disease in young children is noticeable and the frequency in juveniles and young adults equally marked.

Length of History.

1—6 months	8 cases.
7–12 ,, ...	6 ,,
Over a year	5 ,,
Indefinite	4 ,,

The duration of the disease is open to question—the frequency of malaria on the one hand and the latent condition of Kala Azar in its early stages on the other both bringing in fallacies. The cases usually presented features of greater chronicity that the stated duration suggested and generally there was a history of irregular fever attributed to malaria which occurred previous to the present attack. I am inclined to think that the duration was generally longer than stated by the patients.

Deductions as to the seasonal prevalence are very difficult though in general terms it suggests that infection takes place during the cooler months of the year.

I am quite prepared to find this surmise break down on receipt of more accurate information; Dr. Muir states that a large number of cases come up early in the cold weather, *i.e.*, in November and December, and if so, this suggests infection during the rains or hot weather unless the incubation is shorter than we suppose.

The great difficulty I find in this and all other enquiries is that of knowing whether cases referred to were really Kala Azar. In a country riddled with severe and often fatal forms of malaria it is impossible to be sure that Kala Azar is referred to either by patients or even by doctors, unless the parasite has been demonstrated.

In my own investigations the only criterion I adopt is the presence of *Leishmania* as I have been deceived by clinical symptoms on several occasions and in both directions.

Distribution.

I hoped to have found a Kala Azar focus in a village where a number of cases occurred and where minute investigations could be prosecuted, but I have not found such a one. The disease seems to be scattered irregularly throughout the

district without apparent reference to any climatic or geographical conditions. Villages said to be specially infected were inspected but there again the fallacy of chronic malaria obtruded itself. It is curious to note that no particular tendency to house infection could be proved—in one case (No. 65) the mother and son of the patient are said to have died of the disease but this statement was only that of the patient and was unsubstantiated. In many cases on the other hand four or five young persons were living in the house with a proved Kala Azar patient yet presented no symptoms of the disease.

In Madras and in Assam house infection is said to be common, and this fact has been much emphasized as an argument in favour of insect transmission.

Clinical symptoms and signs.

In comparing the clinical features of Kala Azar as I have seen it in Madras and in some carefully studied cases in Bombay, I have been struck with the absence amongst the Kalna cases of some of the most marked features of the disease as ordinarily described.

It may be that only advanced cases came to the Madras Hospitals and that earlier and milder cases might have been found in the out-patient department, or it may be due to the fact that the disease is milder in Bengal than in Madras.

Amongst the 23 cases I have seen in Bengal I should only describe three as being typical of classical Kala Azar. I mean that condition where the patient shows extreme emaciation, emphasized by great protruberence of the belly and œdema of the feet and where the skin is harsh and scaly and the body deeply pigmented.

In a good number of the Kalna cases the patients were fat and robust, bright and cheerful, and beyond enlarged spleens and irregular fever showed no sign of disease. Some such cases showed the presence of large numbers of *Leishmania* in spleen puncture and one of these, a girl who lives near the hospital, is up and about doing her household work and apparently on the road to recovery.

Cases of this sort make me still more chary of trying to estimate the frequency of Kala Azar in a community, for without prolonged and careful study in a hospital it is almost impossible to diagnose the disease except by finding the parasite in the blood or by visceral puncture.

Recoveries are said to be frequent and one often meets with cases where the enlarged spleen and suggestive symptoms have disappeared after an attack of cancrum oris or other septic condition.

If it is true then that Kala Azar is a less severe disease in Lower Bengal than it is in Madras, it is probably due to the disease having been evident a long time in Bengal and that a certain amount of immunity has been established. This is probably the case also in parts of Assam.

Only one fatal case has occurred during my investigation here and the material provided was used for animal innoculation.

Examination of the peripheral blood.

This has not been used as a diagnostic method in many cases as spleen puncture was always available.

It has been carried out in most of the severe and advanced cases but parasites have only been found in two cases and in these in very scanty numbers.

I found no difficulty in finding peripheral parasites in many cases in Madras so I do not think my failure is a matter of technique, but I think it points again to the greater chronicity and mildness of the disease in Bengal. Malarial parasites have been surprisingly infrequent even in non-Kala Azar patients though this part of the subject has not been specially studied. Major Waters, I.M.S., Civil Surgeon of Chinsurah, an adjoining station to Kalna, tells me he finds that only 15 per cent. of cases with enlarged spleen show malarial parasites.

This I take it, is probably due to the fact that all infants and children go through attacks of acute malaria and subsequently become partially immune and in fact "reservoirs" of malaria.

Spleen punctures.

The parasitic infection of spleen juice was very variable in intensity.

In chronic and fibrosed spleens *Leishmania* were sometimes very scarce and might readily be overlooked; sometimes only one or two parasites could be found after half an hour's search even when the film consisted of undoubted spleen pulp.

In other cases large numbers were found and this not always in cases clinically the most intense.

In most cases the *Leishmania* presented the usual form, but in several one found many forms where the nuclear material was surrounded by a considerable amount of protoplasm.

One met with parasites varying in size from the typical ones, 2·5 or 3 microns in diameter, to those as much as 10·0 or 12·0.

In the larger cells the nuclear material was imbedded in the protoplasm and multiplication was taking place into four or as many as ten pairs of nuclei all surrounded by cytoplasm proper to the parasite. This appearance is quite different to that well recognized one where typical Leishmania with a defined limiting membrane are included in an endothelial or other host cell.

(These appearances are shown in the sketch No. 1.) Twelve examinations have been carried out to ascertain whether patients suffering from Kala Azar harbour *Anchytostomes* or other worm parasites.

The results were *negative* in all cases.

EXPERIMENTS TO ASCERTAIN WHETHER BED BUGS HARBOUR THE PARASITES OF KALA AZAR.

Three hundred and twenty-one (321) bugs were caught in the beds and bedding of patients proved to be suffering from Kala Azar. They were dissected and examined microscopically.

Result.—No Leishmania Donovani or any other protozoal parasites were found.

Seventy (70) "laboratory bred bugs" were allowed to feed on a patient suffering from Kala Azar who had *Leishmania* in his peripheral blood (5 or 6 to a slide); they were only allowed to feed once and were examined at various stages from 1 to 30 days. Conditions of temperature were purposely neglected.

Result.—Leishmania of the usual forms were found in one or two on the day after the infected feed but not subsequently.

(Experiment proceeding.)

Leeches.—Seven common tank leeches were allowed to feed on the same patient.

After three weeks they were examined, blood being received by puncture of the living leech. No Leishmania were found.

(Experiment proceeding.)

EXPERIMENTS TO ASCERTAIN WHETHER ANIMALS IN THE ENDEMIC AREAS OF KALA AZAR HARBOUR THE PARASITE.

A variety of mammals, birds, and fishes in small numbers were examined.

Filaria were found (squirrel and dog) and an unrecognized parasite in the liver of a flying fox (*Hæmogregarine* ?) but no Leishmania were found.

Dogs (22) from the bazar also examined for ecto and endo-parasites.

Spleen smears shewed no Leishmania.

Result.—Nil.

(proceeding)

EXPERIMENTS TO ASCERTAIN THE NATURE OF BITING INSECTS IN THE EPIDEMIC AREA.

A collection of biting flies, mosquitoes, ticks, lice fleas, and other ectoparasites have been made and forwarded to Mr. Howlett for identification.

The prevalent species of anopheles are *N. Rossi* and *N. Fuliginosus*.

(experiments proceeding)

EXPERIMENTS TO ASCERTAIN WHETHER KALA AZAR MAY BE TRANSMITTED TO ANIMALS BY INOCULATION.

The material used for inoculation was the juice from the spleen of a boy who died of kala azar.

The spleen was pulped in a mortar with normal saline and the emulsion, which was rich in Leishmania Donovani, injected into the animals within 1½ hours of the boy's death.

White mice.—Number injected. { Negative— 12. Positive— 1.

Exp. No. 10.—Inoculated 1 cc. of emulsion into the peritoneal cavity of a white mouse, 21st August 1912.

The animal wasted and died seven days later. Leishmania were found in the spleen smears in small numbers.

None in the bone marrow, liver, kidney or other viscera.

An emulsion of the spleen of this mouse was put into white rat No. 25.

This animal was killed one month later it was well nourished and did not reveal Leishmania infection either microscopically or by culture. (Rows medium.)

Flying Foxes (*Pteropus edwardsii*).—Three, injected by the peritoneal route, each with about 3·0 cc. of human emulsion (one No. 16 escaped a few days later). Exp. No. 17 died 16 days after injection. A large abscess was found in the abdominal wall when the injection had inadvertently been given.

A good many degenerate but easily recognisable. Leishmania were found in the pus and one large endothellal cell was seen which contained about 30 Leishmania showing early degeneration.

No parasites could be found in the internal organs.

Exp. No. 18. *Flying Fox.*—Received 3 cc. of emulsion. Was ailing and was killed three weeks after injection. It was well nourished and fat and no obvious sign of disease was found in any organ.

No Leishmania were found in the spleen bone marrow, liver or lung.

A few discrete and typical parasites were found in the pancreas and fewer still in the kidney. In the latter organ one large endothellal cell containing 13 typical parasites was seen.

The intestine carefully searched but no ulcers were found and scraping from various parts did not reveal any Leishmania.

Result.—Positive.

Monkeys. (*Macacus Rhesus*).—One large monkey received 10 cc. of the human emulsion by the mouth.

Two months later this animal, which showed no sign of disease, was killed and its organs exhaustively examined.

Result.—Nil.

A second monkey was given 5 cc. of the emulsion by the peritoneal route.

It remained healthy, and after two months and ten days was killed.

It was fat and well nourished and examination of all the chief organs (including hæmo lymph glands suprarenal, mesenteric glands and pancreas) gave negative results.

Monkey.—No. 13.—Received 5 cc. of the human emulsion on 21st August 1912.

A month after injection liver puncture revealed the presence of *Leishmania Donovani* in small numbers.

The general health seemed unaffected and there was no apparent loss of weight. A month later (*i.e.*, two months from the injection) it was again examined. The spleen was found to be enlarged and was readily palpated through the abdominal wall. Spleen puncture showed the presence of Leishmania in fair numbers.

Ten days later it was killed. Leishmania in fair numbers and discrete were found in the spleen, a very few in the liver but none in the bone marrow or any of the abdominal and thoracic organs. The condition was one of early kala azar infection and up to the time of death the animal appear to be healthy.

Result.—(1) One out of thirteen white mice was infected with Leishmania.

(2) None out of seven white rats was found to be infected.

(3) Both flying foxes innoculated showed the presence of Leishmania after a short time (one infected only at injection site and the other had an early general infection).

(4) One out of two monkeys became infected a month after inoculation and later showed early generalised infection.

(5) A monkey fed with infected material showed no infection two months later.

ANIMAL EXPERIMENTS PROCEEDING.

I. 26th September 1912.—*Experiments to ascertain whether a monkey (macacus rhesus) will contract kala azar if it is fed on water taken from a tank which is at intervals fouled by the faeces of Kala Azar patients.*

6th November 1912.—Lever puncture = Negative.

II. *Further experiments to ascertain whether certain animals are susceptible to kala azar*—The virus had been passed from man through a monkey (Experiment 13). The parasites in the spleen of this animal (killed 1st November 1912) were somewhat scanty.

Flying Foxes.

Experiment 28 received 10 cc. splenic emulsion by peritoneal route.
" 29 " 5 cc. " "
" 30 " 5 cc. " "
" 36 " 10 cc. " the mouth
" 37 " x " rubbed into scarified skin.

Monkeys.

Experiment 31 received 5 cc. splenic emulsion by peritoneal route.
" 32 " 5 cc. " "

White Mice.

Experiment 33 received 1·5 cc. splenic emulsion by peritoneal route.
" 34 " 1·5 cc. "

Kitten.

Experiment 35 received 5 cc. splenic emulsion by peritoneal route.

(proceeding).

PROGRESS REPORT ON "SOME OBSERVATIONS ON THE EPIDEMEOLOGY OF KALA AZAR IN MADRAS"

By Vishnu T. Korke, L.M. & S. (B'bay), M.R.C.P. (Edin.), D.T.M. (L'pool), on Special duty, Kala, Azar Enquiry.

I. Distribution of Kala Azar in Madras.

The early history of kala azar in Madras is not available.

From the study of the General Hospital and the Royapettah Hospital records, from June 1903 to September 1912, personal investigations in the city, interviews with the oldest medical practitioners and residents, I can safely say that Georgetown (once called "Black Town") is the cradle of kala azar.

It grew and spread northwards, westwards and southwards (limited eastwards by the sea) by the main arteries of human traffic *infecting them* on its progress.

I have studied carefully an area of nearly 8 square miles and came to the conclusion that the process of permeation of kala azar is very slow.

In the last nine years kala azar has not diffused *evenly* more than 2 miles in any direction of Georgetown.

Roughly speaking then the chief endemic focus of kala azar is restricted to an area whose radius is nearly 2 miles and whose centre is the heart of Georgetown.

The cases reported from the outskirts of the city, are more exported than original ones.

Patients are usually advised to change their residences and they usually select a spot outside of the endemic area but at a convenient distance from the business quarters of the city.

The only exception to this statement appears to be Triplicane.

I am not quite sure from personal observations whether kala azar exists here, as the majority of the residents are Mohammadans and the correct investigation amongst them is a task not unattended with difficulty. They seem to be the last to seek the advice of the modern medical men or in the modern institutions.

Colonel Donovan informs me that the cases living in Triplicane occasionally come to him especially near and about Peter's Gardens.

Except for this small endemic focus, it is not possible for me to say whether kala azar exists in other quarters of Triplicane.

Table I.

Divisional distribution of Kala Azar.

The records of the General Hospital and the Royapettah Hospital (1904—1911) in numerical order.

Division.	Population.	Total cases of kala azar.
(1) Georgetown	142,803	563
(2) Royapuram	76,073	103
(3) Vepery and Choolai	71,299	94
(4) Purasawalkum, Egmore and Pudupet	23,717	84
(5) Chintadripet	26,752	55
(6) Triplicane and Mount Road	71,494	51
(7) Perambur	24,979	32
(8) Royapettah and Teynampet	34,358	28
(9) Mylapore	20,254	21
(10) Nungambaukam	11,751	15
(11) Kilpauk	15,180	9

(*a*) *Density of population and the endemic focus.*

The figures from 1871 to 1911, or for the last forty years, show that Madras is increasing in population. The census statistics (up to 1908) of birth place show that this is largely due to immigration from the neighbouring districts of Chingleput and North Arcot.

Between 1891 and 1901 the great ratio of increase was 12·6 per cent., but in parts of Madras it is still higher.

Owing to establishments of cotton mills, railway workshops, quarters and bazaar of a native regiment, the number of people in Perambur and Vyasarpadi have more than doubled in the last thirty years and the same may be said in certain quarters of the city.

The emigration statistics show that large numbers of persons left Madras for other countries by sea, but only a small portion of them were natives of the city itself.

The average number of persons living in each occupied house is nine, while in the heart of Georgetown it is as high as thirteen.

This overcrowding of Georgetown is an important fact, in addition to very defective hygiene, when one finds that Georgetown is the chief *endemic focus.*

(*b*) *The nature of kala azar.*

Kala azar as it appears in Madras is purely *endemic.* There is not the slightest evidence to show that it ever ran in *epidemics.* The close study of the census * figures, the returns of births and deaths, the divisional mortality, clearly show that the presence of kala azar has had no appreciable effect on them.

The divisional * mortality shows that deaths from "fevers and malaria" are higher in Georgetown and Royapuram than in other divisions.

Many of these deaths are due to kala azar, as one knows that the existence of kala azar is recognised there. Before the days of discovery "fevers and malaria" would have been mistaken for kala azar. Thus from the divisional mortality alone, it appears that Georgetown and some portion of Royapuram are the endemic foci of kala azar and that the increased death-rate of these divisions is partly due to this circumstance.

On the whole, the population is increasing, though there is decrease amongst the Eurasians by 1,000 or so within the last forty years.

Eurasians are more or less a stable community and this decrease may be accounted for by the natural causes and forces. How far kala azar played a role, in the decrease of this nationality, I will refer to in the "Race Incidence."

Out of 480,094 patients who sought advice in the General Hospital (both as in-and out-patients) during a period extending over eight years, 1,264 proved to be cases of kala azar.

In other words, out of every 380 patients examined, one was identified to be a case of kala azar in the above period.

In the Royapettah Hospital (1911—October 1912), the proportion is one case in every 134 patients, the higher ratio being probably due to the fact that the present medical officer (Colonel Donovan) has specialised in this disease.

From table I it will be easy to see the divisional distribution of kala azar in the city.

Kala azar in the Presidency.—There is every reason to believe that kala azar is also to be found occasionally outside of the city in the Presidency. Two positive cases of kala azar came to me, one from Cuddalore and one from Madura. I have seen one positive case at Trichinopoly—a fakir who came wandering from Malabar. He had never been on the north of Tanjore.

A few cases were shown to me at Mandapam, where malaria is so common. Two cases were the picture of kala azar, but as yet I cannot give definite opinion as I have not examined the slides.

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* See Tables Nos 4, 5, 6 and 7, Appendix.

II. Seasonal Incidence.

A study of the relation of the number of cases in the General and the Royapettah Hospitals (1904—1911) with that of rainfall, temperature and dew-point (which are essential factors in the seasonal variation) shows no definite correlation between these individual factors and the cases.

The charts compiled by me (from 1904—1911) show that kala azar is endemic and that sporadic cases occur from time to time. (The charts have not been reproduced in this paper as they show negative results.)

The fallacies in making these charts are the following :—

(1) That a case does not necessarily come for aid in the early stage of the disease.

In the majority of instances one usually sees a late clinical picture of kala azar.

(2) That there is no pathognomonic sign or symptom to *indicate the commencement* of the disease about which a patient may give definite history.

Two early cases under my observations came for dysentery and one for enteric symptoms. The blood examinations showed parasites of kala azar.

(3) That the incubation period of kala azar is not settled as yet, and the statement of the patients as to the duration of illness is often erroneous.

A patient usually dates the commencement of his illness from the time when he is actually ill, either owing to kala azar fever, or its complications (dysentery, diarrhœa, etc.). Consequently one does not get the right clue as to the probable date of incubation and hence of the season.

The lowest mean temperature in Madras does not even approximate the optimum temperature at which the Leishmania parasites thrive in a culture. Hence to say that kala azar in Madras is a disease of the cold season (as has been deduced by other observers) appears to me to be open to argument on this observation alone.

It may be possible to get some clue to seasonal incidence by studying the epidemiology in Madras for a couple of years continuously, but up to date no such study has been undertaken.

III. Race Incidence.

The proportion of Muhammadans and Christian inhabitants in Madras city is higher than in other parts of the Presidency, there being 113 Muhammadans and 80 Christians in every 1,000 of the population against 64 and 27 in the Presidency as a whole.

Tamil and Telugu castes largely predominate. Brahmans are more than usually numerous forming 6 per cent. of the Hindu population.

The Eurasians mostly reside in the "endemic area." In some portions of Georgetown as many as four families (with 10—15—20 inmates in all) reside in a small, low, one-storeyed house.

The Eurasians as a class may serve as the "index" of kala azar in Madras.

They are first to seek the medical advice and hence the detection of kala azar is facilitated in them.

The majority of them stay in the endemic area and virtually they are in an identical condition with others who reside in the most crowded and the endemic area.

From the records of the hospitals for the last eight years, one finds that there is one case of kala azar among Eurasians to every 40 of the total Eurasian population (or 2·5 per cent.).

This high proportion serves to show how readily kala azar is detected in them and how prevalent it is.

After Eurasians kala azar is most readily detected in the educated Hindus, the next among the "other castes" and the last among the Muhammadans. In Hindus the proportion to the total population is 1 to 611 (·16 per cent.).

Race incidence, 1904—1911.

Nationality.	Mean of two censuses (1901-1911).	Total cases (1904-1911).	Proportion to total population.	Percentage.
				PER CENT.
Eurasians	10,775	270	1 in 40	2·5
Hindus	413,279	676	1 in 611	·16
Other castes	In censuses, Indian Christians and other castes have been counted collectively, hence it is difficult to strike proportion and percentage.	281	..	..
Muhammadans	50,184	37	The number of cases is not the correct indication of kala azar in this community ; hence the percentage would be erroneous.	

Race incidence (*January—September* 1912) *as drawn from hospital and private observations.*

	Positive cases by blood examination.	Positive cases by clinical observation.
Eurasians	14	3
Hindus	32	18
Other castes	16	4
Muhammadans	5	3
Total ..	67	28

Race incidence and age and sex incidence (1904—1911).

Year.	Eurasians.				Muhammadans.				Hindus.				Other castes.				Total.
	Males.	Females.	Male children.	Female children.	Males.	Females.	Male children.	Female children.	Males.	Females.	Male children.	Female children.	Males.	Females.	Male children.	Female children.	
1904	18	9	1	..	4	..	..	..	68	11	..	..	30	7	1	..	149
1905	45	25	17	9	8	..	..	..	118	13	1	1	35	5	5	3	285
1906	14	9	3	1	6	..	..	..	75	18	..	..	26	13	6	1	172
1907	7	8	2	4	2	..	..	..	63	15	3	..	24	12	..	..	140
1909	10	3	1	1	4	..	..	..	43	8	..	..	17	5	4	1	97
1908	10	3	2	2	3	..	..	..	61	10	1	..	28	11	1	1	128
1910	23	6	1	1	3	2	..	..	66	14	7	1	22	6	4	..	156
1911	27	2	3	3	4	1	..	..	66	10	1	2	10	5	3	..	137
Total ..	154	65	30	21	34	3	..	..	560	99	13	4	187	64	24	6	1,264

IV. Age and Sex Incidence.

The proportion of the inhabitants between 20 to 40 years of age is as high as one-third of the total. The proportion of women to men is nearly equal, *i.e.*, 98 to 100. The analysis of the age and sex incidence from the above table shows—

1904—1911.

Age and sex.	Eurasians.	Hindus.	Other castes.	Muhammadans.
	PER CENT.	PER CENT.	PER CENT.	PER CENT.
Adult male 10 years upwards	57	82·8	66·5	91·8
Adult female 10 years upwards	24	14·6	24·4	8·2
Male child below 10 years..	11·1	1·9	8·5	..
Female child below 10 years	7·7	·5	2·1	..

It appears from the above table that—

In Eurasians, males are affected twice as often as females, and the adults are effected four times as frequently as children of either sex.

The figures about children practically agree with those of Rogers (20 per cent.) in case of Eurasians at Calcutta and Assam.

In cases of other nationality any inference from the figures is fallacious.

So then kala azar affects all nationalities of all sexes and ages.

This observation is not a new one and only supports opinions of previous observers.

I began to investigate kala azar in Madras from April 1912 and the observations recorded below include a period of six months (September).

The following is the analysis of the cases which have come under my observation—

Total positive cases (blood-examination)	67
Total positive cases (clinically) where blood-examination was negative and I had no further oppurtunity of examining the blood..	28
Total suspected kala azar cases, which proved to be other diseases subsequently..	44
Shown by various medical men. (Some of them were already treated in the hospitals and so were recorded before).	
The others were treated privately	45
Total ..	184

Age and sex incidence in the above cases (January—September 1912).

—	Positive (blood.)	Positive clinically.	Percentage.
Adult males 20 years upwards	22	12	35·7
Adult females 20 years upwards	10	..	10·5
Adult (male) = ♂ child 10–20 years	15	4	20·0
Adult (female) = ♀ child 10–20 years	5	4	9·4
Male child before 10 years	10	6	16·8
Female child below 10 years	5	2	7·3

Percentage figures of children under 10 years and between 10 to 20 years of age agree with those of Rogers' in Assam.

V. Kala Azar its relation with the Houses.

There is a strong belief amongst those working at kala azar and in the profession generally that kala azar is in some way connected with houses.

Patton's work on the bedbug theory of kala azar lends support to this belief.

I undertook special investigations to throw more light on the subject and to study the nature of such houses from the epidemeological standpoints.

The evidence is in a preliminary stage, but certainly it throws light on the subjects, and opens out diffrent channels of hypothesis which must be confirmed by the collection of more evidence.

For a working hypothesis I define these houses as "limited infected centres which either, remain *infective* all the year round or give rise to periodic outbreaks of kala azar."

The objects in studying the houses was to find out, the presence of *any* fresh case—

(1) either among the "contacts" of a case (recovered, gone away, suffering or dead).

(2) or among new tenants of these houses who have never come in contact with the previous case in the house, but who only occupied the once *infected* or ? *infective* house.

It is not possible to give the evidence of a single house studied in this way, individually, so I arrange and sum up the evidence in a tabular form :—

(Evidences 1903—September 1912).

(1) *Occurrence of a case among " contacts " with a kalaazar case.*

(*a*) Study of the houses in which more than one case has occurred—

History of 26 such houses was studied in which 67 total cases have occurred.

Remarks.—There is ample evidence to show (see tables A, B and C.) that case to case infection has occurred. It may be that the infection has died out now, and consequently at the time of my investigations, *i.e.*, April to September 1912, all the inmates of these houses were found to be healthy.

(*b*).—Study of the houses in which only one case has occured :—

Remarks.—Three hundred houses were inspected which once harboured a case of kala azar. The summary of the evidence is as follows :—

(*a*) In some, " contacts " of the cases which occurred here have been traced.

(*b*) In some, original cases are still to be found.

(*c*) In others, cases are dead or gone away, all the traces of their contact is lost and now the houses have been occupied by fresh tenants who are healthy.

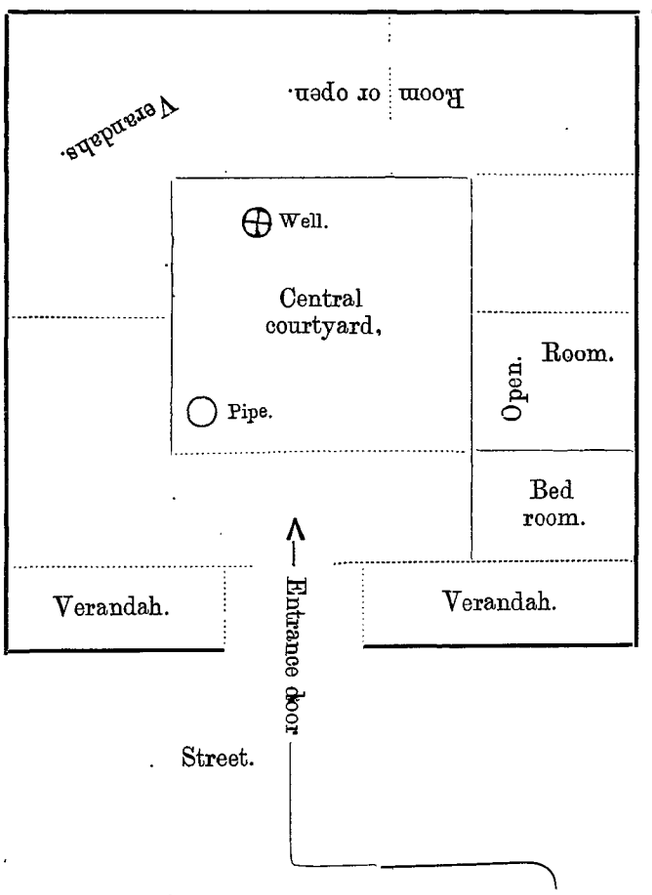
(2) *Occurrence of a case among fresh tenants of houses, who had never come in contact with the actual case, previously inhabiting the house.*

Remarks.—Among 26 houses in which more than one case has occurred and among 300 houses, in which only one case has occurred all the present inmates are found to be free from the disease; I have not given the actual number of the houses which are occupied by fresh tenants, but the evidence seems to be comprehensive when I record that all these 326 houses are free from kala azar except for some of the original cases which are still residing in them.

On the whole I sum up the general conditions of the nature and hygiene of the houses.

(1) The houses in the " Endemic area," are what are called " Inward looking houses of the tropics." A rough diagram will better illustrate than explanation—see page 7 Fig. 1 and Fig. 2.

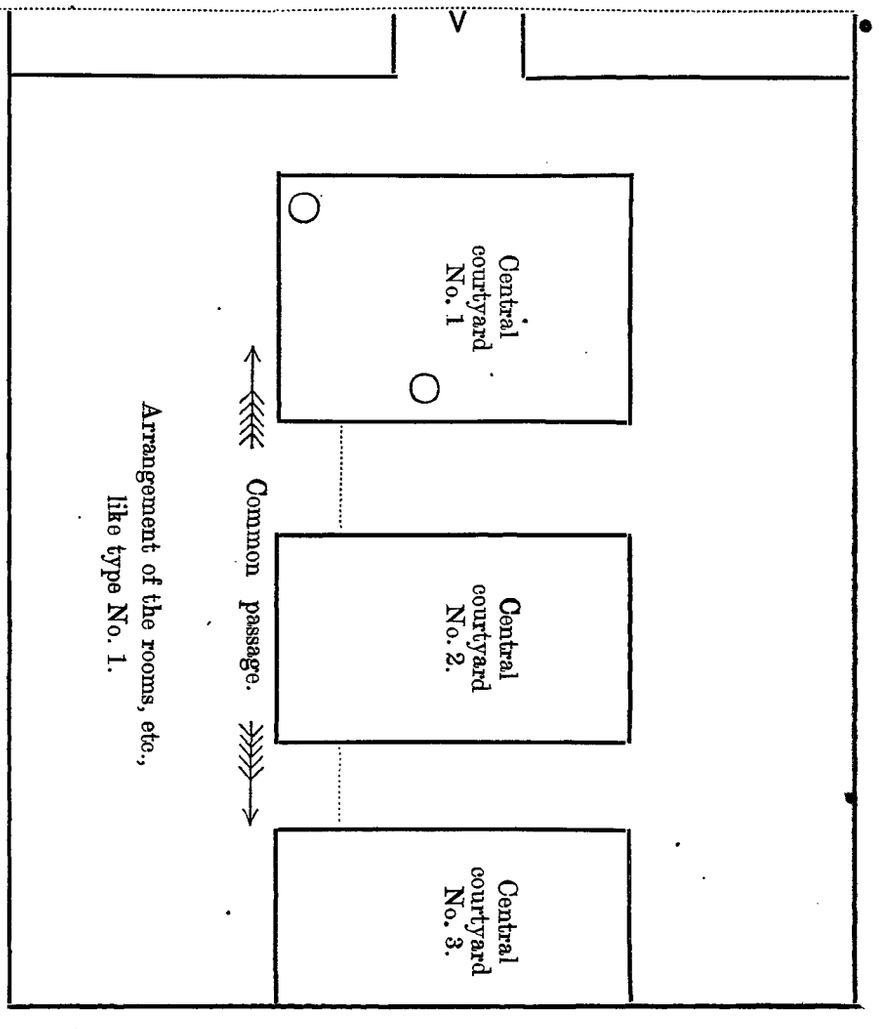
TYPE No. 1. "Inward looking Houses."



TYPE No. 2.

Usually one front entrance.

The house may be storeyed, paved with glazed brick work, the roofs are usually low except in well-to-do houses.


Central courtyard No. 1
Common passage.
Central courtyard No. 2.
Central courtyard No. 3.
Arrangement of the rooms, etc., like type No. 1.

Kala azar an household infection and also where its presence is accounted for, through a "contact."

Evidence—

(1) In household infection—*vide* Table A.

(2) Outside household infection—*vide* Table B.

(3) From institutions and residential quarters—*vide* Table C.

TABLE A.

Evidence to show that kala azar is an household infection—(not a house infection).

Case number.	Name, etc.	Brief details of the case.	Remarks—about relationship, etc.
1	H.'s. child 1 ..	*Private*—K.A.	
	child 2 ..	K.A.	
2	T. male child ..	*Private*—Came from north? K.A. April 1903; mixed with cases Nos. 4 and 5, and used to occupy the same room, April 1903—June 1903; had diarrhœa at the time; left Madras in June 1903; both died subsequently afterwards.	Brothers.
3	A. do. ..		Cousins.
4	G. C. female child.	Eight months later after mixing with case 2 and 3 began to suffer; signs of K.A.; died.	Sister and brother.
5	H. C. male child..	Eight months later after No. 4 manifestation of disease showed signs of K.A.; died 3 years later.	
6	D. D. ♀ child ..	*Private*—+ K.A. (Donovon), 1908.	Sister and brothers.
7	M. D. ♂ baby ..	Died diarrhœa, dysentry (?), 1909.	
8	V. D. ♂ child ..	? K.A. recovered, 1909	Clinically K.A. cases. I am not aware whether blood examination was positive or negative.
9	R. D. ♂ child ..	? K.A. recovered, 1910	
10	V. C. ♂ 10 years. Ev.	Hospital, 1911 .. + K.A.	Brothers and sister. Very likely contact from case 16, who was suffering at the time and removed to the same house.
11	M. C. ♀ 5 years..	Hospital, 1912 .. ? K.A.	
12	S. C. ♂ 10 years ..	Hospital, 1911 .. + K.A.	
13	J.'s. 2 children ..	Hospital, 1905 .. + K.A.	....
14	Master A., Euras.	*Private*—Recovered + K.A.	Brother and sisters.
15	Miss L. A. ..	Recovered .. .. ? K.A.	
16	Miss H. A. ..	.... + K.A.; died.	
17	C. I.	Hospital, 1911 .. + K.A.	Husband and wife. Their two children died. Causes not diagnosed.
18	Mrs. C. I. ..	Roy. Hospital, 1912. .. + K.A.	
19	A. C. D. ♂ Eur...	Hospital, 1911. + K.A.; died.	Nephews. Living in the same house.
20	J. D. ♂	? Hospital	
21	B. S. 13 ♂ Eur...	Hospital, 1911. + K.A.; died.	Brothers.
22	J. S. 20 ♂ ..	*Private*—1912; clinical signs K.A.; blood examination negative. Pt. gone south country.	Living in the same house.

TABLE A—*cont.*

Evidence to show that kala azar is an household infection—(not a house infection)—cont.

Case number.	Name, etc.	Brief details of the case.	Remarks about relationship, etc.
23	N. A. ♂ Hindoo ..	*Private* + K.A. Donovon recovered.	Brother and sister. Brother, father, mother, sister of No. 23 died in the same house within two years cases not diagnosed.
24	Miss A.	Died 1911. ? K. A.	
25	M. I. S. Mh. ♂ ..	*Private*—Died 1909 + K.A. ..	Brothers. Nephew, uncle, aunt, staying in the same house.
26	Master „ ..	Died 1909 + K.A.	
27	Mh. T. S. ..	6 months later (after death of 25 and 26)—signs of K.A. + K.A. Died 1910.	Husband and wife.
28	Mrs. Do.	6 months later 27 wife + K.A. Died 1910–11.	Incubation appears to be six months in cases 26, 27, 28.
29	Mrs. V. C. ..	*Private*— + K.A. Died 1907 ..	Wife and husband. Daughter-in-law, mother and son.
30	Mr. V. C. ..	+ K.A. Died 1908 ..	Son and mother.
31	Mrs. V. C. ..	? K.A. 1912	From the details of history incubation appears to be six months in case 30.
32	Miss S. Ay. ♀ H.	*Private*— + K.A.	Sisters.
33	Sister ..	+ K.A. Died ..	
34	R. Mc. ♂ E. ..	Hospital 1910 + K.A. Died ..	Husband and wife.
35	Mrs. Mc. ..	Hospital 1909 + K.A. Died ..	
36	Mr. F. 23 ♂ E. ..	Hospital 1906 + K.A.	? Brothers.
37	Mr. F. 10 ♂ E. ..	Hospital 1905 + K.A.	
38	G. D. ♂ Eur. ..	Hospital + K.A.	Cousins in one house.
39	J. D. ♂ Eur. ..	Hospital + K.A.	
40	Miss F.	Hospital 1905. Died	Sisters.
41	Miss F. .. .	Hospital 1906. Recovered ..	
42	S.M. Mh. ♂ ..	*Private* + K.A. 1909	Brothers.
	S.M. Mh. ♂ ..	K.A. 1912	
		Two years' duration, clinically positive case. Failed to find parasites (two examinations).	
43	Ch. ♀ H.	*Private.* Died ? K.A. 1905 ? ..	Sister. Case 45. Used to visit her aunt staying in an alternate house. 43 case died.
44	Mrs. N. ♀ H. ..	Aunt 43, 45 + K.A. Died 1910.	Aunt.
45	P. ♀ H.	Recovering + K.A. 1911 ..	Sister.
46	Mrs. C.	Hospital 1911 + K.A. Living ..	Sister and brother and staying in one house for some time.
47	R. S.	Hospital 1911 + K.A. Living 1912.	

TABLE B.

Evidence from outside household infection.

1	G.	Hospital + K.A. Died ..	Brothers.	Servants and master.
2	G.	Hospital + K.A. Died ..		
3	K. P.	Hospital + K.A. ..	.. ..	
4	C. P.	Hospital + K.A. Died ..	Servant of No. 3.	Used to sleep in one house.
5	R. I.	Hospital + K.A. Died ..	Stranger.	
6	P. ♂ N. C. ..	Private + K.A. Died	..	Though living at different addresses No. 7 was constantly nursing No. 6 during his illness, caught infection and died.
7	P. M. ♀ N. C. ..	Private + K.A. Died		
8	A. R. W. ..	? Hospital + K.A. Died	..	Not related but occupied same quarters both in and outside of Madras; both died in Rayapuram in one house.
9	C. I.	Hospital + K.A. Died		

Table C.

Evidence from institutions and residential quarters.

Industrial School.

Hospital cases.

Case number.	Name, etc.		Brief of details of the case.	Remarks about relationship, etc.
1	J. R. 13 ♂ E ..	1905	recovered + K.A. ..	Nos. 1 and 5 probably one common source. Had common address outside the institution, got fever simultaneously though treated in hospital at different periods. Nos. 2 and 3 probably one common source, attacked simultaneously.
2	H. R. 14 ♂ E ..	1905	(died) + K.A. ..	
3	R. M. 12 ♂ E ..	1905	(died) + K.A. ..	
4	L. R. 11 ♂ E ..	1906	recovered + K.A. ..	
5	P. I. ♂ E ..	1906	recovered + K.A. ..	

Presentation Convent.

6	S. H. ♀ 19 Eur.	1906	Hospital, + K.A. ..	Probably sisters.
7	S. H. ♀ 10 Eur.	1907	Hospital, + K.A. ..	
8	D.F. ♀ 14 Eur..	1904–05	Hospital, + K.A. ..	
9	R. L. ♀ 7 Eur...	1905	Hospital, + K.A. ..	

Quarters, Pumping Sation, Rayapuram.

10	Ch. T. 39 ♂ Eur.	1905	Hospital, + K.A. ..	
11	Mr. W. 29 ♀ Eur.	1905	Hospital + K.A. (died). ..	

Quarters, Rayapuram Medical School (Assistant Surgeon's).

Cases—Table A, Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9.

Private.

12	Dr. G's 2 children.	1911 1911	+K.A.	Recovering (August 1912).

Table D.

Evidence indicating that Kala Azar occurs and spreads through one community in a street, more or less through the exclusion of those of other nationalities.

Name of street and year.	Total number of houses occupied by Eurasians in the year.	Number of cases among Eurasians.	Total number of houses occupied by non-Eurasians in the year.	Number of cases among non-Eurasians.
1. Portugese Church Street (Georgetown)—				
1904	Information not available.	1	Information not available.	1
1905	Do.	5	..	1
1907	33	2	3	..
1908	40	2	28	..
1910	23	5	20	..
1911	31	2	8	..
Total ..	..	17	..	2
2. First street (New Town)—				
1904	Information not available.	3	Information not available.	..
1905	Do.	2	Do.	..
1906	21	1	..	..
1908	26	1	2	1
1909	9	1	..	..
1910	Information not available.	1	Information not available.	..
1910	Do.	..	..	1
Total ..	..	9	..	2

TABLE D—*cont.*

Evidence indicating that Kala Azar occurs and spreads through one community in a street, more or less through the exclusion of those of other nationalities—cont.

Name of street and year.	Total number of houses occupied by Eurasians in the year.	Number of cases among Eurasians.	Total number of houses occupied by non-Eurasians in the year.	Number of cases among non-Eurasians.
3. Mada Church street, Rayapuram—				
1905	?	1	?	..
1905	?	..	?	1
1906	27	1	12	..
1907	28	1	19	..
1908	28	1	19	..
1909	40	1	8	..
1911	37	4	16	..
1912	?	1	?	..
?	?	2	?	..
Total ..	..	12	..	1
4. Jones street (Georgetown)—				
1905	?	1	?	1
1908	23	1	4	..
1910	24	2	7	..
?	?	1	?	..
Total ..	..	5	..	1
5. Samboodoss street (Georgetown)—				
1904	?	2	?	..
1905	?	..	?	2
1906	22	1	8	..
1910	35	1	17	..
1912	?	..	?	1
Total ..	..	4	..	3
6. Oil-Monger's street (Georgetown)—				
1904	?	1	?	..
1904	?	1	?	..
1905	?	3	?	..
1909	12	1	6	..
Total ..	..	6	..	..
7. Francis Joseph street (Georgetown)—				
1904	?	1	?	..
1907	9	1	1	..
1908	11	2	4	..
1909	8	3	4	..
1910	11	1	4	..
1911	9	4	2	..
Total ..	..	12	..	..
8. Maddox street, Vepery—				
1905	?	2	?	..
1906	?	2	?	..
1910	28	1	11	..
Total ..	..	5	..	..
9. Arathoon Road, Rayapuram—				
1905	?	2	?	..
1906	15	1	4	..
1908	12	2	7	..
1911	13	1	7	..
Total ..	..	6	..	..
10. Mariadoss street, Rayapuram—				
1910	18	2	5	..
1911	6	1	2	..
Total ..	..	3	..	..

General remarks—

(1) Almost all the houses harbour bugs.

(2) Hygiene, in majority of them is extremely defective.

(3) The majority of houses in Georgetown have well and pipe water-supply.

(4) Many houses in Georgetown are very overcrowded and inhabit as many as four to five different families, the inmates sometimes amounting to twenty in number.

Thus from all the evidence brought forward, it will be clear that houses themselves play very little part, if at all, in transmitting infection.

It may be contested, that my observations extended over a period when the mean Madras temperature was comparatively higher than the rest of the months, and that my period of observation was rather short Granting the objection to be admissible, the evidence is undisputable, and it only serves to show that so far no case has occured in so many houses, in which one expects to find a case—if one accepts the hypothesis that house plays an important rôle in the infection by Kala Azar.

There is one fallacy on which I wish to lay particular stress and that is in supposing that a particular house is a "kala azar house"

I wish to illustrate that fallacy by an example:

Say a house No. 15 shelters four differents families, A, B, C, D, which is not an uncommon condition in Georgetown.

In December 1910 a case occurs in family A. The case stays for six months, dies and the family members then go away to another locality.

In December 1911 another case occurs in the same house, evidently now in one of the families B, C, D.

To a casual observer the occurrence of a fresh case in the *same house* after a year, may mean that house No. 15 is *infective* But the present occurrence of the second case can be explained as well as by "contacts" with the case in family A

(For evidence of "contact" see tables Nos. A, B, C.)

In Madras I have very often observed that a case is usually traced to a case with which the former has come in "contact". The examples are more numerous amongst Eurasians, for I have said before, that cases are easily detected in them for various reasons. Their statement is generally intelligent one. So then it appears to me that a presence of a previous case explains the existence of another, but in what way I am unable to state at this stage of my investigations. At present my conception of a kala azar house can be better explained and understood, by giving an example of a "yellow fever house".* The conditions between the two "houses" differ in the following way. Infected stegomyia are in or about a particular house, in which a case has occurred. It is immaterial then, whether a case exists there or not. So long as there are infected and infective stegomyia present, a susceptible fresh comer will get infected. If the presence of stegomyia is forgotten for a time being, it would give one an impression that the house is a "yellow fever house". The contacts with a yellow fever case is not necessary.

But the same does not appear to be the case in Kala Azar. The house as far as my evidence goes does not play an important part, but the case would appear to do so and herein lies the chief difference between these two examples.

VI. Incubation Period of Kala Azar.

It is difficult to determine the incubation period of kala azar in an endemic area. The same difficulty is experienced as infinding out the correct seasonal incidence where sporodic cases occur. However, there are a few cases which throw some light on the subject.

(*a*) Cases 2, 3, 4 and 5 in Table A, show that Nos. 4 and 5 caught infection from 2 and 3 in April 1903. Eight months later No. 4 showed signs of kala azar, and in October 1904, *i.e.*, sixteen months later case 5 showed similar signs. As the latter is unusually a long incubation period, I believe, case 5 got infection from case 4, *i.e.*, eight months. I cannot positively say that these four cases were absolute cases of

* "Yellow fever house" as was known before the discovery of stegomyia as a carrier.

kala azar, as Nos. 2 and 3 occurred before the time of discovery and they left Madras before that time ; case 5 died in 1907, and it was believed to be a case of kala azar.

(*b*) The study of cases 23, 24, 27 and 28 in Table A show that the minimum incubation period of kala azar was six months.

(*c*) Two cases came from Madura, they were staying at Pamban for nearly one and a half years and then came to Virudupatti (south of Madura) after that time, stayed there for a year or so. Case No. 1, died at Madura afterwards and case No. 2 came to Madras for the first time for diagnosis. These two cases were never in Madras before. The repeated blood examination was negative, so bone puncture was done by Col. Donovan and he found the parasites in the bone marrow.

I have reasons to believe that cases were probably got infected at Pamban.

Four months after their stay at Virudupatti, the boys began to show signs of kala azar. So the minimum incubation period was four months as Virudupatti appears to be free from kala azar.

Dr. Row of Bombay writes me that in his infected monkey by leishmania parasites (kala azar) the incubation period was $5\frac{1}{2}$ months.

This experimental observation, closely agrees with mine, and it is likely that the incubation period *is longer* in natural infection.

VII. * Factors in the spread of Kala Azar in an endemic area like Madras.

From the close study of all the evidence brought forward and taking this evidence in connection with household infection, house infection, "contacts" and spread in the same nationality collectively, I am able to summarize the facts in the following manner. I have no pretensions to assert that the question about the above factors is finally solved. This is practically a preliminary note, on the facts I observed during my investigations. Further investigations will be carried out and I may be able to support or disprove these facts by stronger evidence at some future date.

In the first instance it appears to me that kala azar is an household infection. This fact has been noted by some observers before me and this merely serves to support their observations.

Secondly. It appears to me that for the occurrence of a fresh case, "contact" with a previous case is necessary.

Thirdly. On the strength of the observations taken collectively that kala azar is an household infection, that a contact appears to be necessary and its tendency to run in the same nationality †—it then appears to me that the spread of kala azar is facilitated by an intimate social intercourse where habits, manners and customs of the people allow as such.

Fourthly. If these factors are finally proved and accepted, it follows as a corollary that if a case of kala azar occurs in a particular nationality, the next case likely to occur (apart from the household of the original case) will be from the same nationality ‡ (irrespective of the situation of the house in the same street) and whose social customs admit a free social intercourse. I admit these to be rather bold assertions, but based as they are on the evidence I have brought forward, they may be treated as provisional at the present stage of my observations.

Fifthly. From the close study of the 326 houses, it appears that houses by themselves do not play an important rôle the infection of a case.

Sixthly. From clinical and other observations, I am inclined to believe that there is a particular period in the course of the disease, which is more infective than the rest. This has long been maintained by Donovan and Patton and I agree with them.

From the study of two early cases, I have observed that the disease began like dysentery and enteric fever-symptoms.

* Study of Tables, A, B, C, D. † See Table D (evidence on that point). ‡ Study Table D.

In fact in a private case, the patients had no symptoms but dysentery and fever,—of two months' duration coming off and on. There was no enlargement of spleen and liver. I found the parasites in the peripheral blood. This clinical phenomenon is strongly suggestive. Unless I get more cases of this nature I am not in a position to suggest any mode of transmission. It is a pathological fact that dysenteric and enteric symptoms never manifest themselves unless there are intestinal lesions, and when they happen to be in the initial stage of kala azar, naturally, it leads one to think that intestinal mucous membrane is the primary seat of the disease. It has also been taught by the experience of the diseases that wherever intestinal mucous membrane is the primary seat of lesion, the channel of infection is the gastro-intestinal mucous membrane even if parasites appear in the blood, *e.g.*, enteric is septicaemia infection. But of course in typhoid and kala azar the biology of the parasites is different and I cannot theorize on the observation of one case alone.

There is a school of thought who believe that the leishmania cannot thrive in the fæces because leishmania cannot flagellete in symbiosis or in contamination. In my opinion there is an objection to this mode of thinking. Pathologists are aware of the fact that usually there is a terminal complication due to invasion of other pathogenic bacteria in long-protracted illness. Much more so in a *post-mortem* condition and in organs. Patton's and Macki's experience has shown that the rounded form of leishmania (as it exists in the body) from spleen—*post-mortem*—is pathogenic to monkeys and white rats. My experience on the same spleens have shown that no matter what aseptic precautions I could take, my culture media were contaminated (for making cultures of leishmania). This was not in one case but in as many cases in which Patton inoculated the animals. Under the above circumstances I succeeded cultivating *leishmania donovain* on Row's medium at 18–22 °. C. (July 1912). From the bone marrow from the femur of an infected monkey (Patton), four generations of subcultures were made and could be maintained only in an ice incubator. The first batch of culture kept at laboratory room temperature died out in the first generation. This fact suggests me, that leishmania may not thrive in cultures owing to contamination from the *post-mortem* organs, but still they are capable of infecting the animals. So then infectivity of the parasite and its capability in growing in a culture, are diverse things; cannot the same be said in case of fæces, if at all parasites appear in it?

I only bring this controversial point to show that one cannot deny a possible channel of infection on the strength of partial hypothesis.

It is a clinical fact that parasites appear in large numbers in the peripheral blood—

(*a*) When there are complications like diarrhœa, dysentery as observed by Donovan and Patton.

(*b*) When there is pathological leucocytosis, like pus formation in the body. I have got evidence of three patients in which parasites appeared in large numbers and in whom the *post-mortem* evidence showed that two were complicated by empyema and one by pyo-nephrosis.

These facts tend to support the idea that at that period from causes unknown to us, there is greater multiplication and discharge of the parasites from the endothelial cells and such parasites are picked up in large numbers altogether by the poly morphs. Whether at this time parasites appear in the discharges, I cannot say.

VIII. Conclusion.

So, on the whole, the evidence forthcoming favours either the insect or non-insect theory.

Unless, therefore, the possibility of another channel of infection is negatived by experimental evidence, there are still grounds to suppose, that the etiology of kala azar is not finally solved.

In conclusion I have to thank the President of the Corporation, the Health Officers and the Sanitary Inspectors without whose help I would not have been able to do what I could do in investigations in so short a time.

Drs. Pinto, Rama Rao, Haller, Damrey, Ghouse, and the other medical practitioners have not only shown me their cases, but also supplied me with the valuable information.

Every facility was given to me by Col. Donovon both at the Medical College and the Rayapetta Hospital and by the Medical staff of the General Hospital for the examination of the cases. Finally I have to thank those who have materially helped me in arranging the facts for this paper.

IX. Appendix containing charts and references.

References—

(1) System of medicine, Allbalt and Rolleston, Vol. II, part II, 1907.
(2) Manual of Tripical Medicine, Castellani and Chalmers, 1910.
(3) Fourth report of the Welcome Tropical Research Laboratories (Medical), 1911.
(4) Roger's fevers of the tropics and Millory lectures in B. M. J.
(5) Scientific Memoirs, Nos. 31, 53.
(6) Kala azar Bulletin, Nos. 1. 2, 3.
(7) Directory of Madras. Lennox, Limited 1903—1911.
(8) Imperial Gazetteer of India, Vol. XVI, 1908.

Appendix containing tables in support of the paper.

TABLE No. 2.

Years.	Ratio of total mortality from "Fevers".	Ratio of divisional mortality from "Fevers".								Remarks.
		1 to 3 divisions.	7 to 9 divisions.	4 to 6 divisions.	10th division.	11 to 13 divisions.	14 and 15 divisions.	16 to 18 divisions.	19 and 20 divisions.	
1882	9·3									Population according to census of 1871—397,552.
1883	8·7									
1884	9·4									
1885	9·0									Population according to census of 1881—398,777.
1886	9·5	Not available.								
1887	10·0									
1888	8·4									
1889	10·4									
1890	11·7									
1891	14·8	21·3	15·9	16·9	14·3	12·6	14·5	13·5	15·0	
1892	15·2	16·3	20·2	19·4	14·8	12·6	9·3	12·4	10·9	
1893	14·6	15·9	20·1	19·2	10·6	10·9	9·0	12·2	11·2	
1894	13·5	15·5	16·8	17·8	12·4	10·7	10·0	11·0	9·9	
1895	13·8	16·1	16·0	16·2	14·8	12·0	12·3	12·1	9·3	Population according to census of 1891—452,518.
1896	13·3	16·7	14·0	13·5	13·9	11·9	13·2	11·8	11·5	
1897	12·1	16·1	13·5	13·5	11·6	9·9	7·9	10·6	9·7	
1898	12·1	17·7	14·3	13·8	11·8	11·1	6·4	8·8	7·2	
1899	7·3	10·0	10·8	10·9	4·4	4·7	3·0	4·6	3·6	
1900	13·0	20·0	17·1	17·7	9·7	9·3	4·8	8·7	7·1	
1901	17·9	26·6	23·8	24·1	12·0	14·0	7·5	11·8	10·8	Population according to the census of 1901—509,346.
1902	14·3	20·3	20·6	18·0	8·2	10·1	6·7	10·6	9·1	
1903	12·0	17·0	16·2	15·6	8·9	8·5	5·8	8·8	7·6	
1904	9·8	14·1	13·8	12·0	5·2	7·0	4·2	7·5	6·7	

TABLE No. 3.

Years.	Ratio of total mortality from "Other fevers."	Ratio of divisional mortality from "Other fevers".																		
		3	2	1	7	8	9	4	5	6	10	11	12	13	14	15	16	17	18	19	20
1905	8·0	9·1	10·1	5·9	8·8	10·5	9·1	4·9	6·0	7·2	7·7	8·9	10·6	5·7	6·5	4·7	8·5	8·3	7·1	7·2	6·0
1906	2·1	..	0·1	0·03	2·4	2·5	2·0	2·0	1·7	1·6	1·5	1·3	1·1	1·5	6·3	5·1	4·8	5·0	3·9	1·2	0·9
1907	3·2	2·6	4·3	1·8	2·6	2·1	2·0	1·9	2·5	2·4	0·1	2·9	2·9	2·0	5·0	5·2	5·3	8·4	6·8	..	..
1908	3·8	2·9	4·3	2·7	2·4	2·0	1·8	2·9	4·2	3·7	0·9	4·6	4·5	2·6	2·1	2·5	6·2	6·9	6·2	3·9	3·3
1909	3·6	4·4	5·4	3·0	3·2	2·6	2·3	3·3	4·2	5·1	1·1	3·7	3·6	2·6	2·1	1·9	4·2	4·9	3·5	4·0	3·5
1910	5·3	6·0	7·5	5·5	9·0	7·8	7·3	5·7	5·9	5·5	2·8	3·7	3·5	2·8	3·3	3·8	4·9	3·3	4·4	4·9	4·1
1911 ..	2·1	4·3	5·2	3·9	2·8	2·8	1·7	2·7	1·6	1·5	1·0	2·6	3·2	2·2	1·5	1·3	0 8	0·7	0·6	0·9	0·8

TABLE No. 4.

Nationalities.	Population according to the census of				
	1871.	1881.	1891.	1901.	1911.
Europeans	3,613	39,094	39,742	4,448	4,187
Eurasians	12,013			11,218	10,332
Indian Christians	21,441			25,292	27,293
Hindus	309,521	310,065	358,997	410,648	415,910
Muhammadans	50,964	49,404	53,184	57,331	59,169
Others	..	214	595	409	1,769
Total ..	397,552	398,777	452,518	509,346	518,660

Table No. 5.

Years.	Ratio of total mortality from "Malarial fever."	Ratio of divisional mortality from "Malarial fever."																			
		3	2	1	7	8	9	4	5	6	10	11	12	13	14	15	16	17	18	19	20
1905	1·6	2·0	2·2	1·4	3·8	4·4	3·2	1·4	2·2	1·6	0·04	1·7	1·3	0·8	..	0·01	0·6	0·5	0·5	0·3	0·3
1906	5·7	9·6	10·5	6·4	10·5	10·8	10·3	3·9	4·1	4·5	4 03	7·0	7·1	5·2	0·1	0·02	1·3	1·2	1·2	3·6	2·9
1907	5·1	7·7	9·1	6·2	8·0	9·2	7·7	5·0	5·4	6·1	6·08	4·1	4·3	3·5	0·2	0 06	1·3	1·3	1·5	5·5	4·0
1908	5·4	7·1	8·3	5·6	10·2	10·2	8·9	4·7	4·4	4·7	6·03	4·7	5·0	3·9	1·8	2·01	2·1	2 3	2·6	3·3	2·7
1909	4·9	5·6	7·6	6·1	8·2	8·5	7·3	5·8	4·1	5·8	6·02	5·4	3·7	3·7	2·0	1·03	1·3	1·7	2·3	3·4	2·2
1910	4·6	6·4	8·2	6 5	4·7	4·4	3·4	6 6	6·1	8·2	4·00	4·9	4·9	3·5	1·0	1·01	1·5	2·0	1·9	4·6	5·2
1911	5·6	6·3	7·8	7·6	8·8	8 5	6·8	9·3	6 9	1·0	2·06	4·0	3·0	1·9	2·1	2·07	2·5	2·0	3 0	7 1	8·9

Table No. 6.

Years.	Ratio of total mortality from "Enteric fever."	Ratio of divisional mortality from "Enteric fever."																			
		3	2	1	7	8	9	4	5	6	10	11	12	13	14	15	16	17	18	19	20
1905	0·01	..	0·09	0·07	0·01	0·01	0·2	0·01	0·3	..	0·04	0·01	0·02	0·09	..	..	0 01	0·01	0·03	0·03	..
1906	0·09	..	0·04	0·01	0·07	0·03	..	0·05	0 5	0·07	0·08	0·08	0·07	0 01	0·1	0·06	0·01	0·01	0·09	0·03	0 01
1907	0·08	0·06	..	0·01	0 01	0·06	0·01	0·01	0·1	0·03		0·05	0 03	0·02	0·2	0·01	0·03	0·08	0·01	0 07	0·09
1908	0·07	..	0·02	0·01	0·07	0·01	0·01	0·05	0·2	0·03	..	0·02	0·01	0·02	..	0 06	0·07	0·02	0 03	0·03	..
1909	0·08	..	0·04	0·07	0·07	0·01	0·02	0 01	0·1	0·03	0·04	0·01	0·07	..	0·1	..	0·01	0·08	0·01	.	0·04
1910	0·08	..	0·03	0·02	0·01	0·02	0·06	0·04	0·1	0·01	..	..	0·03	0 02	0·1	0·06	0·03	0·02	0·06	0·1	0·03
1911	0·01	0·1	0·02	0·01	0·08	0·03	..	0·03	0·3	0·05	..	0·02	0 07	0 08		0·07		0·01	0·06	0·09	0 03

TABLE No. 7.

Analysis of the Tables Nos. 2, 3, 4, 5, 6.

Numbers.	Names, divisions (new classification).	Name, divisions (old or popular classification).	Population 1911.	Mean-ratio—divisional mortality "fevers," 1891 to 1904.	Mean-ratio—divisional mortality "fevers," 1905—1911.		Mean-ratio—divisional mortality "Malarial fevers" 1905—1911.	
1	Rayapuram	Tondiarpet and Rayapuram.	26,851	17·4	3·8	4·6	7·1	7·0
2	Monegar choultry		41,851		5·3		7·6	
3	Korukupet		16,454		4·6		6·4	
4	Harbour	Georgetown or Black town.	..	16·4	3·3	3·9	5·2	6·5
5	Kachaleswaram ..		..		3·7		4·7	
6	Esplanade				3·9		4·5	
7	Seven Wells		38,403		4·5		9·1	
8	Frevelyan basin		28,668	16·6	4·3		8·9	
9	Park town		22,804		3·8		6·8	
10	Perambore	Perambore	23,223	10·9	2·1		4·3	
11	Pursewalkam	..	37,106	10·4	3·9	3·6	4·5	4·0
12	Vepery		26,960		4·2		4·2	
13	Egmore		21,954		2·8		3·3	
14	Kilpauk	..	9,546	8·2	3·8	3·6	1·2	1·1
15	Nungumbakam		14,279		3·5		1·0	
16	Chintadripet	..	26,624	10·3	4·7	4·6	1·5	1·6
17	Chepauk		35,779		4·6		1·5	
18	Triplicane		31,451		4·6		1·8	
19	Rayapettah	..	26,787	9·35	3·7	3·4	3·9	3·8
20	Mylapore		20,125		3·1		3·6	

AN ACCOUNT OF AN INVESTIGATION OF THE PREVALENCE OF ENDEMIC KALA AZAR IN THE PLAINS OF ASSAM.

By Capt. T. C. McCombie Young, I.M.S., Deputy Sanitary Commissioner, Assam.

A short account of the past history of kala azar in Assam may be of interest by recalling the main facts of the epidemic of the 80's and 90's. In the Province of Assam, the disease was first observed in the Garo Hills in 1869, and in 1882 a severe form of "Malarial Cachexia" was described as affecting certain areas at the foot of the Garo Hills. This was believed to have first become operative as a source of deficiency of revenue in 1875. This fever was probably identical with the epidemic of Burdwan fever, which devastated the Burdwan division in the decade 1860–1870, and the district of Rangpur in 1871–1876; and it was probably a late extension of this epidemic, which had slowly crept round the barrier of the Garo Hills, having been imported from Rangpur.

The disease having thus obtained a footing in Goalpara, then spread up the Brahmaputra Valley *viâ* the grand trunk road, on the south bank of the river, through the sub-divisions of Dhubri and Goalpara to Kamrup, causing the heaviest mortality in Goalpara during the period 1882–87.

Kamrup on the southern bank being infected, the disease then crossed to the north bank into the Mangaldai sub-division of Darrang and thence to Nowgong in 1890. Heavy mortality occurred, especially in the latter district.

As a measure of the disastrous effects of the disease, it may be noted that in Nowgong the fever death-rate rose from about 4,000 in 1891 by regular stages to 14,000 in 1897, and again declined to about 4,000 in 1902. It is calculated that 54,000 persons, or one-third of the indigenous population, died in this district during the epidemic decade, and that one-fifth of the land went out of cultivation.

By 1896 the disease had reached the narrow tract of sparsely populated country, which gives access to the more open, alluvial plains of the Golaghat sub-division and the Upper Brahmaputra Valley.

Here stringent measures to prevent infected persons from traversing this tract of country were put in force, the epidemic was stayed, and the Upper Assam Valley was saved from its ravages.

Subsequently, the disease in its epidemic form declined almost to extinction in the parts first affected, and in 1901 it was considered that Goalpara and Kamrup were free from the epidemic, except for a few chronic cases in parts of the district.

In reviewing the history of the epidemic in Assam, we may note that the disease took from ten to twenty years to go through its epidemic cycle in a district, and that it spread as far as, and no further than, the Golaghat sub-division of Sibsagar.

In the Surma Valley different conditions prevailed. Although a severe outbreak of fever, with a rise in the fever death-rate, occurred in 1897, following the earthquake, the fever death-rate fell to nearly normal proportions the following year, and the rise was probably malarial, therein differing from the 10 to 20 year wave-lengths of the epidemic curves in the districts affected by kala azar. Furthermore, it had previously been shown that the disease was endemic in this district. The contrast between the heavy mortality caused by the disease in the Brahmaputra Valley and the lightness of its incidence in the Surma Valley is one which is very striking, and the explanation put forward by Major Leonard Rogers is of great importance and interest. In this connection he says "the epidemic travelled through the virgin soil of the northern valley previously unaffected by the sporadic form of the disease and there found a population fully susceptible to its deadly influence, and hence was able to work such terrible havoc".

"If this view of the epidemic is correct, it is clear that unceasing vigilance must continue to be exercised to protect the unaffected upper part of the Assam valley from the insidious extension of the disease, while a fresh outbreak may, in the future, be lighted up by some such extraordinary succession of unhealthy years as caused the spreading epidemic at the foot of the Garo Hills in 1875".

The subsequent history of kala azar in the province has not been marked so far by any epidemic recrudescence, or by epidemic invasion of hitherto unaffected country.

Officers of the Medical and Sanitation Departments, however, have, within the last three years, been reporting the existence of certain areas within which it appears as if some still glowing embers of the disease, remnants of the epidemic conflagration, are displaying activity. In the maintenance of that unceasing vigilance advised by Major Rogers, early and careful scrutiny of the conditions attending any such apparent activity is imperative; and from the first the importance of doing so has been recognised by the Sanitary Department.

I may first lay before you a short account of our knowledge of the situation in certain of these areas in which the apparent activity of the disease had attracted attention, and in which some preliminary work has been done prior to the commencement of the larger survey, which I shall then shortly describe.

Golaghat.—As I have reminded you, it was in this sub-division of the Sibsagar district, that the epidemic conflagration burnt itself out, and it was with regard to this area that the need for future vigilance has been emphasised.

Beyond this region, amid the higher reaches of the river, lie the fertile and prosperous districts of Sibsagar and Lakhimpur. These districts are the seat of the large and flourishing tea industry. The protection of this industry, involving as it does, very large financial interests, and one upon whose continual prosperity the livelihood of a large population depends, an industry, furthermore, to whose vitality and energy, much of the prosperity and advancement of the province in the past is to be ascribed, and in whose hands much of the future industrial prosperity of the province lies, is probably one of the most important problems to be considered by the Sanitary Advisers of the Assam Administration. Any suspicious disease activity in a fringe of country bordering on these hitherto unaffected and populous districts would give rise to some anxiety.

That we have now cause for vigilance in this area, although fortunately not for anxiety, may be gathered from an account of the situation as it is at present. The history of our observations is as follows:—

During the rainy season of 1910, the attention of the Civil Surgeon, Captain Morison, I.M.S., was directed to persistent reports of deaths from kala azar occurring in the Khumtai Mauza, which were being submitted by the Mauzader, now Rai Sahib Dandadhar Barua, a delegate at this Conference.

These had previously been filed as fallacious and included in the fever mortality returns. On visiting the affected area, however, Captain Morison was convinced of the truth of the reports, and notified the existence of the disease to the Sanitary Department. Measures for dealing with the outbreak were drawn up by the Acting Sanitary Commissioner, and I was deputed to investigate the conditions.

My own observations seemed to confirm the opinion of the Civil Surgeon, and the parasite was found in a post-mortem specimen of the spleen of one of the cases.

Major Christophers, I.M.S., was deputed by the Government of India to examine the outbreak. In the report which he submitted he stated his opinion that the disease had probably been introduced into the district ten (or more) years ago, and that it had progressed irregularly from the original foci, showing the typical tendency of the disease to cling to groups of houses and families.

He considered that there was no great tendency to assume epidemic proportions at present, and he was doubtful as to whether it was really more prevalent now than some years ago.

He pointed out, however, that the infection is maintained by the presence of these secondary foci, and that so long as these exist, it is impossible to say when the disease may not assume an active epidemic form.

Meanwhile, measures were being carried out to ascertain the extent of the outbreak, to prevent its spread, and to treat individual cases.

An Assistant Surgeon and a Sub-Assistant Surgeon aided by an Assamese Sub-Inspector of Vaccination, were placed on special duty.

A detailed examination of the whole sub-division was undertaken under the supervision of the Sanitary department. Every village, and every house of every suspected village was visited, and the results recorded upon a 1″ to the mile cadastral survey map.

Clinical notes upon all suspected cases were taken by the Assistant Surgeon in charge of the investigation, who also performed a large number of splenic punctures, and microscopical examination of the slides so obtained have been carried out in the Provincial laboratory. I place before you the maps, which record the number and position of the infected villages existing in the sub-division up to May 1912.

The sub-division consists of 21 mauzas, containing 629 villages, of which four hill mauzas were excluded from the survey, and 396 villages were surveyed.

The following villages were found to be infected:—

Mauza.	Village.	Number of houses infected.
Khumtai	Khumtai	14
	Habischoa	9
Maharani	Dumjuria	13
	Batiparia Lukumani	6
Curjogonia	Batiparia Goria	2
Mowkha	Padumoni	5
Dakhinbengra	Bamongaon	4
Kacharihat	Raidangragaon	2

The results of this survey, which was carefully and thoroughly carried out under the personal supervision of the Sanitary Commissioner, the Civil Surgeon and myself, is gratifying in that it shows that infection is not very widespread. The most severely affected areas of Khumtai and Habischoa are practically contiguous, Dumjuria is a secondary centre, the others show no great signs of activity.

There is, we believe, no cause for anxiety as to the present condition of affairs, although the situation requires vigilance.

We are now in possession of accurate knowledge as to the infected villages and infected persons. The knowledge is kept up to date by a sub-assistant surgeon, who is on duty in this area, and submits monthly progress reports.

Up to date, our attempts at segregation and treatment have met with somewhat qualified success.

In the Khumtai area, owing to the personal influence of Rai Sahib Dandadhar Barua, we have been more successful than elsewhere. The great obstacle to effective action is the apathy of the people, who meet measures aimed at helping them with the objection that it is God's will that they should die. If, however, it is understood that compliance with our instructions is the order of the "Sirkar," they appear to be equally resigned, and it is probable that more rigid measures, of segregation will have to be enforced, if they are to be of any real value.

At present the measures employed are as follows. When an undoubted case is discovered in a family, a new house is built for them on another site at Government expense, and compensation is given for the destruction of presumably infected belongings before removal under the supervision of the Assistant Surgeon in charge. The infected person is provided with separate quarters on the new site, but within the compound of the house, and is prohibited from sleeping or eating with healthy persons.

This degree of segregation is merely nominal, and as may be expected, has not proved effective.

Probably, the solution of the difficulty will be to provide a Kala-Azar hospital or dispensary, with indoor wards for treatment of diagnosed cases of Kala-Azar. The nucleus of such already exists at Khumtai.

It may be interesting in this connection to trace the history of the cases seen and examined by Major Christophers, whose subsequent history I have been able to ascertain.

Out of 15 of the cases in which Leishmania were found in the spleen by Major Christophers, ten have died, and the remaining five have got worse (1911). Out of the remainder with regard to whom information is available, in whose cases no parasites were found in splenic puncture, four are improving, two have apparently recovered, two are in *statu quo*, and only one case has got worse and appears to be now a typical clinical case of Kala-Azar.

These figures seem to show that diagnostic stress may be laid upon the absence of Leishmania as demonstrated by a trained observer in cases which are clinically indistinguishable from those whose spleens yield Leishmania on puncture.

In regard to treatment, it is much to be regretted that no satisfactory line of treatment at present exists, which could be offered with confidence and obvious results to sufferers of a race whose faith in European medicine is of the slenderest. Two cases were treated with salversan in 1910. One case, proved positive by Major Christophers, died, in a state of severe reaction following a dose of ·2 grams salversan. Another case, in whose spleen Leishmania were found, received a dose of ·2 grams salversan, and after a period of reaction associated with rigors and fever, followed by persistent splenic discomfort, recovered entirely.

This case alone recovered of all the cases found on splenic puncture to harbour the parasite, and it gave rise to some hope that salversan might be found a useful remedy. Unfortunately the lack of success that has attended its use elsewhere, together with the difficulties of its use in jungle practice, has proved a deterrent to further trials.

The advice of the Conference is solicited as to whether any trials have been made of Neo-Salversan in the treatment of Kala-Azar. This drug, with its greater ease of administration, would appear to be more suitable for the rough and ready conditions under which it would have to be administered.

At present one cannot do more than recommend a patient to undergo a course of quinine treatment in the hope that his case, which is clinically one of Kala-Azar, may be of the type, which yields no parasites on puncture and appears to yield to quinine.

A reliable remedy is badly required, and the want of it terribly hampers the measures of segregation, on account of the difficulty of inducing the people to submit to treatment and segregation.

As to the popular attitude towards the disease, local interest has been successfully aroused with the object of preventing the spread of the disease, and the people have been warned as to the risk of communication with infected families and villages.

They themselves are thoroughly alive to the importance of preventing immigration of infected persons, and they are generally ready under a little paternal pressure, to submit to reasonable measures of segregation, which do not entail unnecessary hardships on individuals.

When public opinion seems sufficiently educated for such a measure, the application of India's Epidemic Diseases Act to certain areas with reference to Kala-Azar should be considered. It should be possible to prohibit unauthorized migration from infected areas, and isolation of infected persons should be made obligatory, with generous and sympathetic provisions for the sufferers and their relatives. These questions, of how to grapple with the disease and how to extinguish it in its endemic foci, will have to be considered when the results of our survey of the province come to hand.

Kamrup.—Another investigation has been in progress in the district of Kamrup. This district was involved in the epidemic conflagration and is known to contain endemic foci.

In March 1911, the Civil Surgeon, Kamrup, drew attention to the prevalence of Kala-Azar in a village in the thana of Rangiya in a report suggesting certain

measures to deal with the disease. A Sub-Assistant Surgeon was placed on duty for a year to carry out the measures recommended by the Civil Surgeon under his supervision. He carried out investigation as to the extent of the infection and destruction of infected property was attempted but without the thoroughness attending the Golaghat measures. Fourteen villages were found to be infected out of 67 examined, 82 deaths are reported to have been caused by Kala-azar in the area under examination during the last eleven years, and there are now 26 cases of the disease. Nothing definite is known as to the absense or presence of Kala-azar elsewhere in the Kamrup district, in which, however, sporadic cases are known to occur.

Sylhet.—It was observed that a considerable number of deaths from Kala-azar had been reported from the Chhatak and Sadar thanas of Sylhet in 1910, and the attention of the Civil Surgeon was drawn to it, and a Sub-Assistant Surgeon deputed to assist him in the investigation. On looking up the past history of Sylhet with regard to Kala-azar, it was found that the presence of the endemic form of the disease had been established by several observers.

Goalpara.—Attention was drawn to yet another affected area by the Deputy Commissioner of Goalpara in his tour diary, who reported that in the Dudnai thana during the twelve months from March 1911 to February 1912, 113 deaths from Kala-azar had been reported, and he remarked that "considering the extraordinary virulence of previous epidemics of Kala-azar in neighbouring parts of the district in previous years these figures are serious".

Mangaldai.—The Sub-Divisional Officer of the Mangaldai sub-division of the Darrang district has recently reported the prevalence of Kala-azar in the Ambagaon Mauza in which the Mauzadar reports the presence of 90 cases.

From the foregoing account it will be seen that the presence of endemic foci of Kala-azar is tending to attract attention. There is no reason to believe that this increased attention is due to any tendency of the disease to assume again epidemic proportions. But it must be remembered that we have seen the rate of kindling of the epidemic fires is very slow and the time it takes to burst into flame is measured by years. Where in other parts of India the advent of plague or outbreaks of epidemic malaria are perils to be feared, in Assam Kala-azar is perhaps the greatest potential menace to public health, for any recrudescence of the epidemic of the '80's and '90's would be a disaster of the first magnitude to Assam.

The situation at present appears to be this—that in an unknown number of areas in the Lower Brahmaputra Valley and throughout the Surma Valley, there are still glowing points of slow combustion endemic foci. Further more, in the Upper Assam Valley, which is the main centre of the important tea industry, there exists a population so far untouched by the endemic form of the disease, and hence presumably a rapidly combustible material for an epidemic fire, and that adjacent to this inflammable material there exists in Golaghat an area of combustion of not inconsiderable activity. The situation, while it cannot be considered to be fraught with any immediate danger, is one that requires vigilance.

It was the opinion of Colonel R. N. Campbell, C.I.E., I.M.S., Inspector-General of Civil Hospitals and Sanitary Commissioner, Assam, that the present period of quiescence should be utilised in preparations against a day when more serious conditions might arise, if the behaviour of the disease were not kept under observation.

As the first step in framing preventive measures, it appeared to be extremely desirable that we should know the exact extent to which the health of the province is tainted with the Leishmania infection, and a scheme to effect this was drawn up. Government approval to the scheme for the survey of the districts of the province known to be affected was accorded and this survey is now proceeding.

In framing this scheme, although an ideal arrangement might have been to place a worker in each sub-division of the plains districts, the numbers necessary to effect this, would for financial and administrative reasons, have been excessive and for this reason the districts of Lakhimpur and Cachar and the sub-divisions of Jorhat and Sibsagar of the Sibsagar district, together with the hill districts other than the Garo Hills, were excluded from the proposed survey as no foci of endemic disease are

believed to be present in them, and it had been considered sufficient for the present to ask the Civil Surgeons, dispensary Sub-Assistant Surgeons and Vaccination Staff of these unaffected districts to be on the watch for any cases that may come to their notice.

The survey is, therefore, at present confined to the districts of the Garo Hills, Goalpara, Kamrup, Nowgong, Darrang and Sylhet.

Sub-Assistant Surgeons have been assigned to areas corresponding in most cases to the boundaries of the sub-division of these districts, and it is hoped that the survey of each sub-division will be completed in one working season.

The work of these sub-assistant surgeons, 14 in number, is being supervised by two assistant surgeons, one for each division, and the supervision of the whole survey has been entrusted to myself.

A short preliminary course of instruction in the points, which they would be expected to investigate, has been given to the sub-assistant surgeons before starting them on their work. They have been instructed in the cause, symptoms, treatment, and prevention of the disease, and how to take a spleen census according to standard methods. They have been furnished with a map of the sub-division in which they will work, and they have been instructed to visit every village in the sub-division and make inquiries into the presence or absence of Kala-azar therein, marking on the map the result of their inquiries and recording their observations in a diary.

In the case of the infected villages, subsequent detailed survey by house-to-house visitation, will be undertaken.

They have been provided with a peon and a small stock of medicines of a simple nature, to enable them to gain the confidence of the people, but not such as to tempt them to indulge in private practice. Consolidated pay at the rate of Rs. 60 per month has been fixed.

The Assistant Surgeons will, if possible, see all areas reported to be infected, and secure splenic punctures for microscopical examination and verification in the provincial laboratory. They will be responsible for the maintenance of the records of the work in each sub-division and for its proper continuance and timely completion.

Specimen diaries, containing the standing orders as to the investigation, also the clinical note-books in which they will record their observations on individual cases, are shown.

The observations in the clinical note-books are in accordance with a scheme drawn up by Captain Mackie, I.M.S. It is hoped that this investigation will prove of considerable value to him in furnishing him with preliminary information as to what areas are most likely to repay his attention, and we have arranged that he shall be kept regularly informed of the progress of the work.

We hope that on the termination of the present investigation, we shall be able to say exactly where endemic foci of Kala-azar exist. The question of controlling them, and of dealing with them effectively will then be enormously simplified, and we hope that it will be within the scope of practical sanitary administration to do so.

Further more, the complete survey may perhaps add some valuable items to our knowledge of the etiology of the disease, and may aid Captain Mackie by suggesting profitable lines of research. For instance, could it be determined that the areas of endemic prevalence coincided with the distribution of some biting insect, evidence such as first led to inculpation of the Glossina responsible for the conveyance of sleeping sickness, might thus be brought to light.

In conclusion, I have to apologise for taking up your time with matter which is in no way original or new. We hope, however, that by another year, the investigation which I have outlined will be productive of some valuable and interesting information, and for the present I would invite constructive criticism as the scheme and advice as to the conduction of the investigation from a gathering which is so eminently qualified to offer it.

APPENDIX I.

STANDING ORDERS FOR SUB-ASSISTANT SURGEONS ON THE KALA-AZAR INVESTIGATION.

Sub-Assistant Surgeons investigating sub-divisions will, in the first place, proceed to district head-quarters. There they will obtain the census village table for 1911 from the Deputy Commissioner's office and copy out from this, mauza by mauza, the number of villages contained in each mauza, number of houses, and total population in each village, the name of the mauzadars of each mauza. The names of Gaonburas will be obtained from Gaonbura Registers at the different sub-divisional head-quarters. This table must be carefully copied and preserved. In this they will note against the name of each village, as they visit it, the serial number allotted to it in their diary, and whether it is "infected," "free" or "doubtful."

When this table is completed, a programme of investigation will be drawn up by the Sub-Assistant Surgeon, in consultation with local officials, *e.g.*, the Inspector of Vaccination, by which he will arrange to have visited personally every village in the sub-division allotted to him before the commencement of the ensuing rainy season, and have made enquiries as to the presence or absence of *kala-azar* in each.

This tour programme will be carried out subject to the approval of its details by the Deputy Sanitary Commissioner, to whom it will be transmitted by the Assistant Surgeon in charge, with any suggested alterations he may think proper, before September 30th. The touring work will commence on October 25th on the termination of the Puja holidays in accordance with the approved tour programme.

Sub-Assistant Surgeon on *kala-azar* investigation duty will maintain diaries and will enter in them the dates of their visits, the names of the villages they visit, and the names of the village Gaonburas, whose signature they will obtain. They will also enter the names of the house-holders whose houses they visit to obtain information. They will enter in the column for remarks short notes on points relevant to the investigation; and where cases suspected to be *kala-azar* are found, they will note opposite the entry of the house-holder's name the serial numbers of the cases in that house and notes of these cases under their serial number will be kept in the clinical note-book.

Reports will be submitted by them to the Deputy Sanitary Commissioner, through the Assistant Surgeon in charge of their circle, showing villages visited and the number of suspected cases of kala-azar discovered.

This will be compared with the tour programme previously drawn up, copies of which will be with the Deputy Sanitary Commissioner and the Assistant Surgeon, from which it will be seen whether the Sub-Assistant Surgeon is adhering to this.

Maps.

Maps, $\frac{1}{4}$" to the mile, will be supplied for each sub-division. One copy of each will be maintained in the Deputy Sanitary Commissioner's office, one copy of each sub-division of his jurisdiction will be kept by the Assistant Surgeon, and one copy of the map of his own sub-division will be maintained by the Sub-Assistant Surgeon. Villages which are found to be infected, are to be marked upon the map with a small red circle within which the serial number of the village corresponding to the entry in his diary will be inscribed.

If the name of the village does not appear upon the map supplied, he will mark its approximate position with reference to names shown upon the map.

The Assistant Surgeon and the Central Office will keep their maps up to date in accordance with the reports submitted by the Sub-Assistant Surgeon.

Sub-Assistant Surgeons will thus have in their possession:—

I.—Villages Census table.
II.—Approved tour programme.
III.—Diary.
IV.—Clinical note-book.
V.—Map.
VI.—Medicine case.

The Special Research Officer, Captain Mackie, I.M.S., will be supplied with details of reports on villages and areas found to be infected immediately upon receipt of the report.

Duties of the Assistant Surgeons in charge.

Their duties will be to check the work of the Sub-Assistant Surgeons under them. They will endeavour to visit all areas reported to be infected to examine the suspected cases and record their opinion as to the accuracy or otherwise of the diagnosis.

They will obtain slides by splenic puncture, wherever possible, in accordance with the instructions and precautions laid down and forward them, in the manner directed, to the Laboratory at Shillong for examination.

Results of the examination will be reported by the Laboratory to the Central Office and to Captain Mackie direct. In addition to inspecting the infected villages and the entries in the diary relating to them, they will also check the entries in the diaries of the Sub-Assistant Surgeons in regard to villages which are reported to be free from the disease. They will go to a certain number of these villages and by visiting the house holders, whose names appear in the diary, and verifying the signature of the Gaonbura, satisfy themselves that the diaries are reliable records of work done.

T. C. McCOMBIE YOUNG, Capt., I.M.S.,
Deputy Sanitary Commissioner.

APPENDIX II.

Serial No.	Date.	Names of villages visited.	Signature of Gaonburas.	Names of house-holders visited in each village.	Remarks and number of cases in clinical note-book.

APPENDIX III.

Clinical Note-Book.

In taking notes on suspected cases, Sub-Assistant Surgeons should note the following points in the clinical note-book :—

Name. Sex. Age.
Occupation. Caste or nationally.
Village. Mauza.
House in which case resides.

Past History.

(1) Any previous history of kala-azar in the family or household.

(2) In which house the disease first began and whether any other similar case of disease are known to have occurred in the house previous or subsequent to the present patient's illness.

(3) Nature of house surroundings, whether—

(*a*) heavy jungle, or light jungle, or open country, or in a town,
(*b*) close neighbourhood (i) of tanks, (ii) of running water,
(*c*) drinking water obtained from (i) well, (ii) tank, (iii) river,
(*d*) domestic animals living in or near house, *e.g.*, cattle, dogs, cats, fowls, ducks or any other animals or birds,
(*e*) verminous insects frequenting house—mosquitoes, bugs, lice, ticks, biting flies.

History of Present Illness.

Date of onset.

Whether it came on with rigors, fever, sweat, as in malaria, or whether it came on gradually.

Was the fever continuous or intermittent?

How long has the spleen been enlarging?

Other symptoms noticed, *e.g.*, dysentery, or diarrhœa.

Swelling of feet.

Cancrum oris.

Emaciation.

Pigmentation of skin.

PRESENT CONDITION.

Patient complains—

On examination, note the following points—

Temperature?

State of the tongue?

Anæmia?

Puffiness or œdema of feet or face?

Change of colour of skin?

Skin rough or smooth or itchy?

Diarrhœa or dysentery?

Emaciation?

Cancrum oris or any septic complication?

Splenic enlargement (under following headings) :—

1. Palpable, one finger's breadth
2. „ two „
3. „ three „

} below costal margin.

4. At or below umbilicus.

Enlargement of liver?

Presence of ascites?

Result of splenic puncture, if done?

T. C. McCOMBIE YOUNG, Capt., I.M.S.,
Deputy Sanitary Commissioner.

APPENDIX IV.

KALA-AZAR INVESTIGATION.

Report of Sub-Assistant Surgeon in Sub-division during period from to

Names of mauzas.	Names of villages visited.	Names of villages found infected.	Number of persons found to be infected.	Remarks.

THE RELATION OF KALA AZAR TO MALARIA

By Rai Kailas Chandra Bose Bahadur, C.I.E., L.M.S.

I fear I shall be thrown into the background and be taken for one who is twenty years behind time, if at this stage of our bacteriological progress I were to make a feeble attempt to link Malaria and Kala Azar together. But from close observation of a few cases, circumstances have so transpired that I cannot resist the temptation of bringing to the notice of the Conference certain facts which when carefully analysed might lead to profitable discussion on a subject the importance of which can never be overrated. Without wasting the time of the Conference I would read the report of three cases placed under my close observation from the commencement of the illness till its termination by death or recovery. A fourth case is still under treatment.

History of cases and clinical phases of the disease.

Case No. 1. A married girl, aged 16, of respectable parentage nursed in the cradle of luxury and accommodated in a big commodious house with extensive open space all around and situated in the centre of the District No. 1 and Ward No. 6 of Calcutta, contracted fever and was at once placed under treatment of two competent doctors one of whom was a Professor of the Calcutta Medical College. The fever continued for a day only and then subsided. Her temperature came down to normal and she had her quinine. On the third day fever returned and her temperature went high up to 105. As anticipated it passed off in twelve hours and quinine was vigorously pushed on. The case was pronounced to be one of benign tertian and it actually proved so. The fever did not return and the patient was fairly convalescent. She was quite happy for only one week and then there was a relapse which was speedily checked by quinine. The young lady did well for a few weeks under quinine and arsenic. Only a week after the discontinuance of quinine her fever returned, but unlike her previous attacks it was not accompanied by chill or rigor and the temperature did not go higher than 103, but the duration was rather prolonged. The type was tertian and yielded to quinine. She became convalescent; but this time she was a little bit dull and apathetic although her temperature kept normal all day through. She soon manifested symptoms of quininism and felt sick; her quinine was stopped. She did not improve much and change of air was suggested by her medical advisers. The idea of change was not very much relished by her friends and she was not allowed to go out of town, as they all apprehended that a relapse might come on the day of the new moon which was approaching fast. Owing to a mysterious coincidence the temperature of the girl rose to 102 on the day of the new moon and it came down to normal during morning. Quite unexpectedly her temperature rose again during evening, so that the type of the fever was changed. This time from tertian it became quotidian which absolutely refused to yield to quinine. The temperature daily ranged between 99 and 101. In spite of all care and most active treatment the fever persisted and quinine this time most unhappily proved powerless. Her spleen was enlarged and she felt weak and became emaciated. She occasionally suffered from diarrhœa. Cachexia soon supervened and her spleen was tremendously enlarged although there was no perceptible enlargement of the liver. From the date of her last relapse she was never free from fever, and now became a confirmed case of Kala Azar with all the characteristic features of the disease. The record of temperature shows that the patient had two distinct rises every day. This special feature was noticed from the third month of her fever till her death. Hæmorrhage from Cancrum Oris closed the scene. She suffered for full 18 months. As a relative and friend I had to see her daily. Her blood was not examined.

Intermittent fever merges into Kala Azar.

Case No 2. Fatima, a Mahomedan girl, aged about ten years, came under my treatment for a smart attack of intermittent fever, quotidian, which was rather obstinate in its character and after persisting for 10 days yielded to quinine which was given in very large doses. Fifteen grains in one dose was given followed by another ten grains dose after three hours, and she had another five

grains during evening. On the following day she had another ten grains. The fever left her but quinine in small doses was continued for a fortnight. The little girl had no complaint during the time she continued taking quinine. Exactly a fortnight after its discontinuance she had a relapse, but this time the fever readily yielded to quinine. Special instructions were left with the father that two grains of quinine should be given daily until she picked up health and strength and that her temperature should be taken twice daily. The father absolutely abided by my instructions, but the child did not improve. She was brought to me one morning and I noticed a slight enlargement of the spleen. On looking over the record of the temperature I found that the temperature had remained absolutely normal for 5 days, and then there was a rise of half a degree and occasionally one degree during evening. The tongue was clean, there was no jaundice; there was a tendency to diarrhœa which was checked by regulating the diet and peptonising her milk. Every day she was brought to me and every day I noticed some rise of temperature. The forehead was hot but the temperature did not rise higher than 99·5. A bath was ordered and the patient felt refreshed after it; but her temperature rose to 100. From this day the temperature never came down to normal again and it ranged between 99 and 101. The enlargement of the spleen was rapid and it gradually reached the umbilicus. It was hard and slightly painful. She gradually became anæmic and her complexion became dark. Her strength failed and she became absolutely helpless. Any medical man could say from a distance what she was suffering from.

Cancrum Oris cures Kala Azar.

As the patient objected to intramuscular injection, atoxyl was given by the mouth for one week but to no purpose. She had diarrhœa which further exhausted her. She soon got Cancrum Oris and every hope of her recovery was lost. Rectal injections were tried and answered our purpose very well. Soon a healthy change was noticed in her sore. Sloughs separated leaving the borders clean and granulating. The gangrenous smell disappeared and she showed signs of improvement. The spleen became soft and its size diminished, and in course of three months it became almost normal. Her appetite returned, her pallor was gone and to the surprise of the parents and their friends, she ultimately recovered though she was hideously disfigured. Her blood was not examined.

Quinine inert in Kala Azar.

Case No. 3. An unhealthy looking Bengali youth, Mohedra, aged 17, was brought to me for the treatment of fever which he had been subject to for a few months. The fever was of intermittent type and was readily checked by quinine. When constipated they used to give him Epsom salts. The fever was suddenly checked by Bi-hydrochloride of quinine. He was advised to continue medicines for a few weeks and to keep a record of temperature. There was no appreciable enlargement of the spleen and liver but his look was sickly. The boy returned to me after 10 days with a clean sheet of temperature. He visited me again on the following day because he had had fever the previous night. On taking him to task he admitted he had stopped quinine for a couple of days only. This time he determined to take it for three months. The fever was checked by one big dose of quinine and the same advice was given regarding the record of temperature and use of quinine. In spite of all necessary precautions the fever returned after nine days and this time it was very resistant, even repeated injections of Bi-hydrochloride of quinine failed to prevent it or alter its character. The fever returned regularly every afternoon preceded by chill and left him at 12 midnight with copious perspiration. Three weeks elapsed and no appreciable change was noticed. The spleen was enlarged. Blood was examined with negative results. Quinine was stopped and he was placed on a general tonic. His lungs and heart were absolutely sound; on deep inspiration the border of the liver could be felt. From early morning up till 2 o'clock he was absolutely free from fever. The patient lost all confidence in quinine, and at the request of his friends placed himself under the treatment of a Kaviraj and I lost sight of him. He returned to me after several weeks and from his very look I could say that he was suffering from Kala Azar. He looked dark and very much emaciated and his abdomen became prominent. Spleen very much enlarged, liver slightly so; he had anorexia but there was no insomnia. Except a slight burning sensation of the hands and feet he had no other discomfort to complain

of. His temperature was persistingly high; he was advised to try the bracing air of the hills. He went to Madhupur where he caught cold and suffered from bronchitis; he was taken to a village in the district of Bhagalpur where he grew worse and after an absence of three months from Calcutta he was brought back again. This time on examining his chest I found that both the lungs were riddled with cavities and he ultimately succumbed to phthisis. He had no occasion to go out of Calcutta prior to the onset of the fever.

Kala Azar harbours Phthisis.

Case No. 4. Mamood Bhai, a Mahomedan, aged 26, belonging to a tolerably wealthy family contracted fever in February last. It was of a continued type, and resembled very much enteric in its character and course and subsided by crisis on the 23rd day. His convalescence was fairly rapid and in the course of a few weeks he completely recovered his health. In the beginning of June last he got high fever which ultimately proved intermittent and readily yielded to quinine. Two weeks after the first attack he got a relapse which was of a very mild type and again subsided on the exhibition of quinine. The patient was well only for a few days and then the fever returned again, but it was so slight at the commencement that no special heed was paid to it. It used to come with slight oversensitiveness of the body and the temperature was not higher than 100 degrees. A big dose of quinine drove it away and the patient was ordered to take quinine in five grains doses twice daily. His appetite did not return and he did not make much improvement. His friends were advised to record his morning and evening temperatures. It was found that there was only a difference of half a degree between morning and evening temperatures. This state of things went on for a week, when suddenly the disease changed its character and his temperature ranged between 99 and 103 degrees. His blood was examined but no new light was thrown on the nature of the fever. His spleen was slightly enlarged; he had obstinate hiccough which persisted without remission for three weeks. The patient in spite of all care is going down hill. His spleen is very much enlarged, liver slightly so. There is harrasing throat cough and the condition of the patient is really miserable. It is really a case of Kala Azar and although the parasite has not been discovered, still the blood counts very nearly go to establish the diagnosis. Colonel Calvert, Major Rogers and Colonel Browne have seen the patient and were unanimous as regards the diagnosis of the case.

The cases of the nature I have just described are not uncommon in Calcutta, I have seen a number of them, but for the fact of my not having been able to follow their course from beginning to end, I dare not take up the time of the Conference in bringing them before it. The question now arises whether Kala Azar is an independent disease or only a form of Malarial fever where the parasites are not affected by quinine, and under circumstances undergo metamorphosis. In the present state of our knowledge about their cycle and the circumstances under which they lie dormant within the system, we cannot positively say whether the parasites may not ever change their phase and so be capable of producing a set of symptoms quite different from those ordinarily seen. Time alone can remove the doubt. We do not deny the possibility of transmission of the disease through the medium of bed-bugs; but considering the fact of the absence of a second case in the family of the patient whose report forms part of the subject matter of this paper, we are reluctantly compelled to underestimate the value of the theory. I need hardly mention that there is no scarcity of bed-bugs in the Indian portion of the town of Calcutta.

Difficulty in differentiating Kala Azar from Malaria.

I have very carefully watched the cases and I must candidly confess that I am puzzled to find out the special point which clinically differentiates Kala Azar from Malarial fever. Since Kala Azar has found a separate place in the nomenclature of diseases, we have discontinued to use the old phrase "Malarial cachexia" in our annual return of diseases. In the old record of the Medical College Hospital we find that obstinate cases of Malarial fever were returned under the head of Malarial cachexia.

In the pre-bacteriological age, physicians in treating these obstinate cases of fever very largely used mercury in form of ointment which they used to rub

under the armpits of the patient till his gums were slightly affected. They also largely used turpentine in the shape of epethem frequently applied over the spleen, and in extreme cases they had recourse to moxas. A good number of cases recovered under this heroic system of treatment which simply induced leucocytosis. The report of such cases may be found in the record of our Medical College Hospital. The practice of treating chronic cases of fever with enlarged spleen by the application of moxas and setons, has not yet fallen into disuse. In the suburbs of Calcutta there are professional men who make their livelihood by treating cases only by moxas, and I have heard from a reliable source that in Cossipore which is only 2 miles distant from Calcutta, there is a place where people come from various parts of Bengal to have their spleens cured by moxas.

Agents which induce leucocytosis are capable of curing Kala Azar.

The late Dr. D. B. Smith, at that time Principal of the Medical College, at the request of his House Physician allowed 12 inmates of the Hospital to be treated by 'Jharas,' and it is curious to note that 3 of them completely recovered and there was appreciable improvement with the rest. These cases tend to prove that the induction of leucocytosis is the essence of this method of treatment. It is indeed very difficult to find out the missing link between the two diseases. From the report of cases placed before you, you would find that in all of them the fever at the commencement was of intermittent or tertian type; it gradually changed its phase and became quotidian and finally converted itself to continued fever. One would be naturally inclined to believe that from the date when the fever assumed a continued type and resisted the action of quinine, it deviated from its usual Malarial course and entered into the field of Kala Azar. But how one class could be so quickly displaced by another class of organism remains a problem the satisfactory solution of which could alone draw the line of demarcation between the two diseases. The object of my introducing the subject for discussion is simply to ascertain whether there is any means by which Kala Azar can be clinically diagnosed in its early stage, for if we can do it we may reasonably hope to reduce the rate of mortality. Blood counts and search for parasites are the only weapons we have got at our disposal; but we cannot absolutely rely on them. They sometimes betray our confidence; and it is often extremely difficult to persuade the patient to submit to the operation. Besides, examination of blood does not conclusively differentiate Kala Azar from Malarial fever. Much stress has been laid on the presence of Leucopoenia in Kala Azar but is it absolutely wanting in a chronic case of Malarial fever.

Moxas tried in the Medical College Hospital with good results.

Conclusion.

THE INVESTIGATION OF PROTOZOAL DISEASES WITH SPECIAL REFERENCE TO THE DIFFERENTIATION OF TRYPANOSOMES

By Captain F. P. Mackie, I.M.S., on Special Duty, Kala Azar Enquiry.

The differentiation of protoza and especially of trypanosomes is more difficult and more complicated than the corresponding problem in a bacterial disease. There is a good deal of confusion in regard to the former question, and it is my object in the present paper to point out the lines on which such an investigation may be carried out.

The scheme I suggest is that which is employed by Surgeon-General Sir David Bruce and was used by us, the members of the Sleeping Sickness Commission, when working with him in Uganda. Those who find themselves faced with such a problem may be safely recommended to follow the methods of so distinguished an authority, and I need offer no apology for bringing these methods before the notice of this Conference.

My experience of this sort of investigation is not entirely confined to the question of trypanosomes, but the methods I now advocate may be for convenience focussed on this particular kind of infection and the scheme modified or extended to meet the peculiar conditions met with in other diseases. Investigation should be carried on under the following headings :—

1. Morphological Characters of the Protozoon.
2. Its Animal Reactions.
3. The Natural Transmitting Agent or Intermediate Host.
4. The Reservoir.

In addition to these there are some other less important methods of differentiation as follows :—

5. Cultural characters of the protozoon.
6. Laveran's crossed immunity test.
7. Serum diagnosis—including the " attachment" phenomenon.
8. Geographical distribution.
9. Effect of treatment.

I will now proceed to say a few words about these methods and shall confine myself to the Trypanosome group of diseases, and to them only as far as my actual experience in Uganda justifies me.

In addition to the work on Sleeping Sickness which has been dealt with separately in another paper, we applied some or all of these methods of investigation to the following Trypanosomes and these species will be used as examples of the methods we employed.

Trypanosoma Pecorum.—(2) *T. Nanum*, (3) *T. Uniforme*, (4) *T. Vivax*, (5) *T. Brucei*, (6) *T. Evansi*, (7) *T. Ingens*, (8) *T. Elephantis*, (9) *T. Gallinarium*.

I.—Morphological Characters.

In the living condition.—This method may give very valuable indications as to the probable species of Trypanosome under examination. Comparison between two Trypanosomes should be made as nearly as possible under indentical conditions. The blood should be examined either as it is drawn, or better after mixing with an equal volume of 1 per cent Citrated Saline.

The same time should always be allowed to elapse between the time the blood was withdrawn, and the time it is examined.

The points to be noted in fresh preparations are :—

(1) The kinds of movement exhibited.

(2) Relationship of the parasite to the celular elements of the blood.

(3) Morphology.

(*a*) Shape and size whether uniform or polymorphic.

(*b*) The locomotor apparatus.

(*c*) Appearances of the cytoplasm.

(*d*) Appearance of the nuclei.

(4) Abnormal appearance of the blood (such as auto-agglutination).

(5) Further information afforded by dark ground illumination, *e.g.*, discharge of granules (Fry).

The following Trypanosomes of those under consideration have characteristic or suggestive movements.

T. Pecorum.—This Trypanosome hides itself under a clump of Red Blood Corpuscles (which seem to become auto-agglutinated) and it may be recognised by a rapid vibratory movement which it imparts to the red cells, itself remaining invisible. Periods of rapid oscillation alternate with periods of rest. The Trypanosome is not often seen out in the open but when it is, it is generally glued on to a corpuscle which it shakes violently. It does not move far from one spot, *i.e.*, it is non-translatory.

The nucleus is generally visible as a stippled area and the micronucleus has a refractile vacuole near it.

The cytoplasm is free from granules.

The undulating membrane is not well developed and there is no free flagellum.

T. Uniforme.—Is somewhat similar to *T. Pecorum* but exhibits active translation from place to place and rarely stays in one position. Its movements sometimes slow down but do not cease and return as is the case with *T. Pecorum.* The refractile vacuole is absent, otherwise the morphology is similar.

T. Vivax.—Is the most characteristic of all. It shoots with great swiftness across the field, clearing a path through the corpuscles like a "destroyer" through waves and leaves a broad wake behind it. It continues its career till it reaches the edge of the cover glass where it churns up the corpuscles with every evidence of astonishing energy. Its movements are too rapid to allow of its morphology being studied in the fresh state.

T. Ingens.—Was found in the blood of cattle and in the blood of antelope frequenting the same pastures.

This huge Trypanosome possesses a wide and well developed undulating membrane and flagellum, and it moves deliberately amongst the red corpuscles with rippling movements passing down its undulating membrane like the wind bellying out a sail.

These remarks suffice to show that occasionally valuable evidence may be obtained from the observation of Trypanosomes in the fresh state.

The further study of morphology is made after *fixation* and *staining*.

The methods we used were those described by Bruce, Hamerton and Bateman in their paper, "A Trypanosome from Zanzibar." P. R., Section B, Volume 81 of 1909, page 16 *et seq.*

Thin blood films were fixed by being placed for a few seconds whilst still moist in a wide mouthed bottle in which had been placed a few drops of 4 per cent Osmic Acid and Glacial Acetic Acid. The films were quickly removed and were put into spirit or absolute alcohol and when dried were ready to stain. This was generally done in a 2 per cent solution of Glenisa's stain in distilled water and the films allowed to remain in this overnight. If overstained they may be cleared in orange tannin solution which however seems to impair their permanency.

In examining the morphology of Trypanosomes fixed and stained the following points should be observed:—

(1) Careful measurements.

Lady Bruce who executed all the drawings produced in the investigation used to draw all the parasites to a scale of 2,000 diameters with the camera lucida.

The exact shades of colour were painted in afterwards.

The measurements were made along the middle of the Trypanosome with a pair of compasses with a stride representing 2 micro millimeters and the total length and breadth recorded.

Twenty or more consecutive Trypanosomes were measured in this way (all dividing forms being omitted) and an average struck.

As a further refinement the method recommended by Lingard may be used. This consisted in measuring the separate parts of the Trypanosomes as follows:—

The distance from the posterior extremity to the micronucleus, the diameter of the micronucleus, the distance from the micronucleus to the posterior limit of the large nucleus, the diameter of the large nucleus, the distance from the anterior limit of the micronucleus to the anterior extremity of the body and from thence to the tip of the flagellum.

The careful measurement of Trypanosomes is very important because though individuals of the same species vary considerably amongst themselves, yet, they vary within definite limits and the average length over a large number of counts is surprisingly constant. For this purpose it is necessary that all specimens should be subjected to exactly the same processes throughout, both in fixing and staining and in measurement, for it is certain that some fixatives produce more shrinking and distortion than others. It is also certain that an attempt to measure an undulatory object direct from the slide with an eyepiece micrometer is very fallacious. When a series of Trypanosomes have been measured and the result plotted out, it may be found that there are marked differences in certain individuals, that is there may be "long" and "short" forms "stumpy" or "tadpole" forms. This constitutes polymorphism or dimorphism. Thus *T. Gambiense*, *T Brucci*, are dimorphic, whilst *T. Pecorum*, *T. Nanum*, *T. Vivax*, *T. Uniforme* are monomorphic.

If curves are plotted and compared it is possible to draw a difference between two species of Trypanosomes which vary in length within the same limits. Thus Sir David Bruce* in comparing *T. Brucei*, *T. Evansi* (two Trypanosomes generally considered to be morphologically indistinguishable) has shown that their curves and maxima are quite different and differentiation may be assisted in this way.

(2) Shape of Trypanosomes.

This varies considerably and is best observed from a number of carefully executed drawings. It is easy to draw fallacious conclusions by examining a few specimens under the microscope. If drawings of two or more species are compared differences are more readily appreciated.

* R. S. Proceedings, B. Volume 84, 91, page 186.

Lantern slides.—Shewing the morphological difference in various Trypanosomes.

(3) Macro and Micro nucleus.

Following morphologists like Minchin, one always refers to the flagellar extremity of the Trypanosome as the anterior and the non-flagellar or blunt extremity as the posterior end.

In the living state they generally move flagellum foremost and so the small nucleus (the Kineto nucleus) is posterior to the large (or Tropho) nucleus. This is so in all true Trypanosomes but the micro-nucleus is anterior to or very close alongside in *Crithidia*, like *C. Grayi* the natural flagellate of the tse-tse fly. It is at an appreciable distance from the posterior extremity in some, such as *Trypanosoma* (*T. Gambiense*) or very closely applied to it as in *T. Vivax*. The macro nucleus varies in size and is nearly always about the middle of the body, but in some (as in *T. Rhodesiense*) it is occasionally far back near the small nucleus.

(4) The locomotor apparatus.

The undulating membrane may be wide and well developed as in *T. Ingens* or *T. Gambiense*, *Brucei* and *Evansi*, or may be poorly developed as in *T. Pecorum*, *Nanum* and *Vivax*.

In amphibian trypanosomes and in *T. Ingens* it is thrown into folds or goffered like an Elizabethan frill.

The flagellum is an important diagnostic feature, because it is sometimes free and sometimes not free; that it is either continued beyond the anterior extreme of body or it stops short at that extremity. Trypanosomes with a well developed undulating membrane generally have a free flagellum (*T. Brucei*) and those with a weak narrow membrane have no free flagellum (*T. Pecorum*).

(5) Cell contents.

Some trypanosomes shew marked granulation of the cytoplasm, this is particularly so in *T. Brucei* as will be seen in the photographs. Others have reticulated protoplasm like *T. Vivax*, whilst in others the protoplasm seems generally to be homogeneous like *T. Pecorum*. In *T. Ingens* and in some amphibian trypanosomes, a marked oblique or crossed striation is seen which is due to the presence of what are believed to be primitive muscle elements (myonemes).

II.—The Susceptibility of Higher Animals.

This is a very large and important aspect of the problem of trypanosome differentiation, and to the laboratory worker it may be added, a very expensive one. In a complete investigation of this nature the parasites must be injected in considerable quantities into one or more of all the available domestic and laboratory animals, and the following observations made:—

(1) Is the animal susceptible or not?

(2) What is the incubation period?

(3) What is the course of the disease in the animal?

(4) Is the disease fatal, and, if so, how long after the disease was produced?

(5) What are the *post mortem* appearances?

It is very important to note that susceptibility is by no means always indicated by the presence of trypanosomes in the circulating blood, but sometimes only by injection of the blood into another species of animal known to shew parasites in the blood stream.

For instance, in Uganda it was found that certain antelopes were very susceptible to *T. Gambiense*, but the parasite was never seen in the blood stream nor was their health affected, yet the antelope readily infected tse-tse flies.

In the summary at the end of the paper, the animal reaction of the trypanosomes under review will be seen and some idea gained as to the complexity as well as the importance of this part of the subject. In actual practice much information may be gained from the use of a few laboratory and domestic animals, and we found that a good deal could be done with cattle, goats and sheep, monkeys, dogs, rabbits, rats, mice and guinea-pigs.

T. Pecorum affects cattle, sheep, monkeys, dogs, white rats, and mice, but did not appear in the blood of goats or guinea-pigs.

T. Vivax affects cattle and goats, but was never seen in the blood of sheep, monkeys, dogs, guinea-pigs, rats or mice.

T. Nanum (so like *T. Pecorum* in morphology) affects cattle and goats, but neither sheep, monkeys, dogs, guinea-pigs, rats or mice.

So in investigating a cattle disease where the appearance of the trypanosome suggested the Pecorum-Nanum-Uniforme group the blood of the cattle was put into dogs and goats, if the former became affected and not the latter the disease was almost certainly *T. Pecorum*, but if *vice versâ* then *T. Nanum* was probable.

III.—The Transmission of the Disease in Nature.

This part of the problem is in its infancy and is beset with many difficulties. An attempt to imitate natural condition in the laboratory is surrounded with fallacies and because a given fly may be found capable of transmitting diseases from one animal to another under the artificial condition of the laboratory, it does not necessarily follow that this fly is the responsible agent in nature. For instance, we did a deal of work in the transmission of *T. Pecorum* and found that in the laboratory *Glossina Palpalis*, the human tse-tse fly, was capable of transmitting the disease from infected to healthy animals, but we found that widespread epidemics occurred amongst cattle in the absence of these insects. Flies of the species *Tabanus* were strongly suspected on epidemological grounds of being the carrier but experimentally it was never proved.

As to *T. Vivax*, there is pretty strong evidence to shew that *G. Palpalis* is the true carrier. Flies caught on the lake shore were found to be naturally infected with *T. Vivax* and were able to transmit the disease to clean animals when they were allowed to bite them. Enormous and rapid development of trypanosomes in the probosis of *G. Palpalis* is characteristic of infection with *T. Vivax*, as this phenomenon is never seen in *G. Palpalis* when infected with the parasite of human Sleeping Sickness.

Further, wild antelope killed on the lake shore were found to be naturally infected with *T. Vivax* which was found in its blood. Reference may be made to the facts already proved that *T. Gambiense* is transmitted by tse-tse flies; *T. Lewisi* by the rat flea and rat louse; Schizo-trypannum Cruzi by a Reduvial bug, and *T. Equiperdum* by sexual intercourse in equines. This shows what a variety of ways these parasites have chosen in order to perpetuate their species.

In deciding whether a given insect should be accounted the true intermediate host of a disease, it is necessary to bear in mind certain rules which I express in the form of postulates.

I. The parasite should be found in the insect in its wild state and the distribution of the disease and of the carrier should coincide, remembering that the intermediate host may exist without the disease, but where the disease is spreading the insect carrier must be present.

II. The parasite should be shewn to be capable of living, developing and perhaps passing through certain stages of its life history in the body of *laboratory bred* specimens of the suspected carrier which have been fed on infected material. (This eliminates the confusion liable to be caused by the presence of natural parasites in the insect. Hereditary transmission of these must be excluded.)

III. The disease should be transmissible from a diseased to a healthy susceptible animal by the intermediary of *laboratory bred* insects of the appropriate species.

If we apply these postulates to well known protozoological diseases, we find that:—

The mosquito malaria theory satisfies all three postulates, so does the action of the tse-tse fly in sleeping sickness, the rat flea in plague, the tick in the transmission of African Spirochaetosis, and the louse transmission hypothesis in Indian relapsing fever. The *stegomyia* is the proved carrier of yellow fever, though it only satisfies part of the first and the third (which is the important postulate) and similarly the louse may be considered to be the true carrier of typhus fever though the micro organism concerned has not been identified. The rôle of the bed bug in Kala Azar is in a less stable position as only postulate II is as yet satisfied.

IV.—*The Reservior.*

Until recently this interesting phenomena was unknown in the bionomics of bacteria, but now it is known that the reservoir in protozoology and the "carrier" in bacterial diseases such as typhoid, cholera, diptheria, are in a sense analogous. There is the difference that the "reservoir" of protozoological infection is generally a mammal of another species which has become insusceptible, probably owing to racial immunity produced by recurring ancestral infections acting either on the race as a whole or more probably affecting the species in a particular infected locality. This is not the case in the bacterial carrier which has become immune owing to a more or less recent attack of the disease from which it has recovered.

In some protozoal diseases, such as piroplasmosis, it is probable that the immunity is conferred by infection soon after birth.

In these diseases the infantile attacks are generally mild, but if an individual escapes or grows up in a non-infected neighbourhood and is transferred in adult life to the company of reservoirs and intermediate hosts, a very severe and often fatal form of the disease follows. This accounts for the phenomenon frequently seen in stock raising countries where importation of healthy animals from a clean locality into another apparently healthy, but really infected herd, results in a fierce and fatal epidemic amongst the imported animals and amongst them alone. Our important observations about the antelope and cattle reservoirs of sleeping sickness have been referred to in some detail in another paper, and similar observations have been made by us in the case of *T. Vivax* which is found in the lake shore antelope, but especially in Bruce's original work in which he was the first to point out the part played by buffalos and wild game as a reservoir of the tse-tse fly disease of cattle in South Africa. Similar observations have been made by other observers concerning the influence of domestic cattle in India in relation to outbreaks of surra, and it is probable that the dog plays some part in the spread of *Leishmania* infection in Mediterranean countries. It should be remembered that the actual parasitic infestation of reservoirs may be extremely scanty or apparently absent. In such cases it may only be testing the animal with the appropriate intermediate host that the evil powers of the reservoir can be proved. It was found that certain antelope infected by the Uganda Commission with sleeping sickness, remained constantly infective to tse-tse flies and through them to other susceptible animals for over a year, though from first to last the most painstaking efforts failed to reveal the presence of the parasite by microscopic examination. Therefore apparent insusceptibility of an animal to a protozoon parasite does not prove that it may not in certain circumstances act as a reservoir to that parasite.

V.—Cultivation of Trypanosomes on Artificial Media.

The medium used is that described by Novy and MacNeal which is a mixture of blood and agar. Some trypanosomes grow readily on this medium whilst others have hitherto defied all attempts to cultivate them outside the body.

It is difficult in the present state of our knowledge of the cultivation of trypanosomes to say what place this will take as a means of differentiating one species of trypanosomes from another, for when cultivation is successful such a diversity of shapes and sizes arises that all semblance to the type form is lost.

Comparison between the two photographs shewing culture form of *T. Pecorum* and *T. Vivax* will make the point clear. These two parasites grew readily in blood agar medium, but cultures of *T. Gambiense* were not successful.

Other methods of differentiating trypanosomes have been described, but as none of these have come within the experience of the writer they will only be briefly referred to.

VI. One of the most important of these is the "crossed immunity test" as used by Laveran.

This is a difficult and somewhat expensive test to apply and though subject to certain fallacies it affords valuable evidence in suitable cases. It requires that a series of animals should be kept going in the laboratory which are immune (by repeated inoculation) to particular trypanosomes. If the trypanosome under identification is injected into this immunised animal, the animal does not develop any further disease if the species are the same, but if the species injected is different to that against which the animal has been immunised, then infection with that new disease follows.

VII. The agglutination of trypanosomes by a specific serum may also be used in distinguishing species, but the test is stated to be uncertain in its results. A new method has recently been described whereby trypanosomes treated *in vitro* with a heated specific serum exhibit the power of attaching themselves to red corpuscles. The value of this "attachment phenomenon" has yet to be decided. A new field of observation is just being opened up in the question of development of trypanosomes in the tissues of the mammalian host. Some parasites (*e.g. Schizo trypanum Cruzi,*) are believed to undergo schozogony in the tissues of their hosts. Then again much interest surrounds the changes which the parasites undergo in the carrier or intermediate host; this has been instanced before when shewing how markedly the development of *T. Vivax* in *G. Palpalis* differs from that of *T. Gambiense* in the same fly.

The foregoing remarks will give some idea of the difficulty which the protozoologist finds in verifying the position of a new trypanosome, a process more difficult, more lengthy and more expensive than that required for the identification of a new bacillus.

The tables which follow summarise briefly the information given in the previous pages.

Table I.

The morphology of trypanosomes.

Table II.

Animal reactions.

The transmitting agent.

The effect of cultivation, etc.

List of photographs and lantern slides.

(1) *T. Pecorum.*

(2) *T. Vivax.*

(3) *T. Brucei.*

(4) *T. Nanum.*

(5) *T. Uniforme* (formerly called *T. Cazalboui*).

(6) *T. Evansi.*

(7) *T. Ingens* (from Bull).

(8) *T. Ingens* (from Reed Buck).

(9) *T. Elephantis.*

(10) *T. Gambiense.*

(11) Avian and Amphibian trypanosomes.

(12) Cultural forms of *T. Vivax.*

(13) Cultural forms of *T. Pecorum.*

(14) Cultural forms of *T. Gallinarium.*

(15) *Crithidia Grayi.*

Papers published in the proceedings of the Royal Society to which reference has been made in the preceding pages.

Vol. 81. (1) "*Trypanosoma Ingens*" (Nov. sp).

(2) A note on the occurrence of a Trypanosome in the African Elephant.

Vol. 82. (5) *Glossina Palpalis* as a carrier of *Trypanosome Vivax* in Uganda.

(6) Report on a collection of blood parasites made by the Sleeping Sickness Commission, 1908-1909, by E. A. Minchin, M. A., Professor of Protozoology in the University of London.

(7) "*Amakebe*" a disease of calves in Uganda.

(9) Experiments to ascertain if cattle may act as a reservoir of the virus of Sleeping Sickness.

(10) Trypanosome diseases of domestic animals in Uganda. I. *Trypanosoma Pecorum.*

(11) II. *Trypanosoma Brucei* (Plimmer and Bradford).

(12) III. *Trypanosoma Vivax* (Zeimann).

(13) IV. *Trypanosoma Uniforme* (Sp. Nov.).

(14) V. *Trypanosoma Nanum.*

(15) Experiments to ascertain if the domestic fowl of Uganda may act as a reservoir of the virus of Sleeping Sickness. (*T. Gambiense.*)

(16) Experiments to ascertain if antelope may act as reservoir of the virus of Sleeping Sickness. (*Trypanosoma Gambiense.*)

(17) Experiments to ascertain if certain Tabanidae act as the carrier of *Trypanosoma Pecorum.*

Reports were also published dealing with the distribution and biting flies and ticks in Uganda.

TABLE I.

Name.	Movement.	Measurements in U.			Shape.	Mono or dimorphic.	Macro nucleus.	Micro nucleus.	Undulating membrane.	Flagellum.	Cell contents.	Remarks.
		Max.	Min.	Average.								
T. Pecorum... ...	Active with periods of quiescence. Translation slight. Local agglutination of R. B. C.	16·0	10·6	13·3	Short and stout ...	Mono-morphic ...	.....	Small round and near posterior extremity.	Poorly defined ...	Not free ...	Generally homogeneous.	
T. Nanum	Similar to *T. Pecorum*...	16·0	11·0	13·5	Short and stout ...	Mono-morphic ...	.....	Small round and near posterior extremity.	Poorly defined ...	Not free ...	Generally homogeneous.	Morphologically undistinguishable from *T. Pecorum*.
T. Uniforme ...	Marked power of translation. Active without quiescent period.	19·0	12·0	16·0	Rather more slender and tapering quickly, anterior to macro-nucleus.	Mono-morphic ...	.....	Small and nearly at posterior extremity.	Closely applied poorly defined.	Short free flagellum.	Reticulated without marked grannules.	Morphologically resembles *T. Vivax* but smaller and less active.
T. Vivax	Excessively active. Dashing across the field of vision.	29·0	16·0	24·1	Elongated. Bulging behind and attenuated in front of large nucleus.	Mono-morphic ...	.....	Small round and situated right at the posterior extremity.	Poorly defined ...	Free	Reticulated non-grannular.	Readily distinguished by its activity in fresh specimens.
T. Brucei	Rotating and tumbling without translation.	34·0	15·0	23·6	Short and stumpy or long slender.	Dimorphic ...	.....	Small round and near to posterior extremity.	Well developed and folded.	Long free portion.	Chromatin grannules well marked in front of large nucleus.	Resembles *T. Evansi* and *T. Gambiense*.
T. Evansi	More motile and translatory than *T. Brucei*.	34·0	18·0	24·0	Considerable variations in size and shape.	Mono-morphic (Bruce).	.....	Small round near posterior extremity.	Well developed like *T. Brucei*.	Long free portion.	Grannules anterior to macro nucleus smaller and less evident. (McFadyean.)	Almost indistingiushable from *T. Brucei*.
T. Ingens	Deliberate translation and fine rippling movement of undulatory membrane.	122·0	72·0	96·0	Irregular indented outline, well proportioned.	Doubtful ...	Oval in form, lies across the body. Homogeneous.	Close behind macro-nucleus and surrounded by non-staining area of vacuoles.	Well marked, goffered.	Free ...	Markedly chromatophilic myoneme arrangements.	Somewhat resembles *T. Thileri* but much larger. Resembles avian and reptilean types. See *T. Gallinarium*.
T. Elephantis ...	Not seen in living state	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....
T. Gallinarium ...	Translatory power limited.	65·0	52·0	60·0	Elongated to tapering point behind micro-nucleus.	Mono-morphic ...	Band like lying across body. Structure homogeneous.	Between macro nucleus and long tapering post extremity.	Broad and folded ..	Long free portion.	Reticular chromatophilic myoneme arrangements.	Much smaller than *T. Ingens* but of similar morphological type.

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TABLE II.

Name.	Cattle.	Sheep.	Goats.	Monkeys.	Dogs.	Rats.	Mice.	G. Pigs.	The carrier.	The Reservoir.	Cultivation.	Remarks.
Tryp Pecorum ...	+	+	—	+	+	+	+					
	Incubation 6·7 days ...	16 days ...	...	12·3 days ...	11·3 days ...	12·6 days ...	14·7 days ...	—	Probably a tabanid possibly a *Glossina*.	Not known ...	Readily cultivated.	
	Duration 63 days ...	105 days ...	...	64·0 days ...	42 days ...	21 days ...	26·0 days ...	—				
Nanum ...	+	—	+	...	...	...	...	...				
	I. P. ... 20 days	...	16 days ...	...	...	...	...	...	Not known ...	Not known ...	Not attempted.	
	D. ... 141 days	...	71 days ...	...	...	...	...	...				
Uniforme	+	...	...	...	...	...	...	...	Not known ...	Not known ...	Not attempted.	
Vivax	+	...	+	...	...	...	...	...				
	I. P. ... 18 days	...	22 days ...	...	...	...	...	...	Almost certainly *Glossina Palpalis*.	Antelope ...	Readily cultivated.	Multiplies freely and in a few hours in the lumen of the proboscis of *G. Palpalis*.
	D. ... 89 days	...	56 days ...	...	...	...	...	...				
Brucei	(No inoculations done in Uganda.) Kills mice, rats, dogs, monkeys, cats in a few days. „ rabbits, equines, pigs and guinea pigs in a few weeks, „ cattle, goats, geese and fowls in a few months, (Castelleni and Chambers).					...	...	...	*Glossina Morsitans*	Game *e.g.*, buffalo and antelope.	Not attempted in Uganda.	In the laboratory may be transmitted by species of *Glossinæ* other than *Morsitans*.
Evansi	(No inoculations done in Uganda.) ... ... Kills horses, mules, cattle, camels, elephants, as well as many laboratory animals.					...	...	...	Tabanid suspected	Not known ...	Not attempted in Uganda.	Said to be transmitted also by abrasions and wounds by direct inoculations.
Ingens	+	Apparently harmless to cattle.			...	...	...	...	Not known ...	Probably game	Not attempted.	
Gallinarium ...	.....	Apparently harmless to fowls.			...	...	...	...	Not known ...	Not known ...	Readily cultivated.	
Elephantis	.....	No inoculations done. ...			...	...	...	...	Not known ...	Not known ...	Not attempted.	

THE BODY LOUSE (PEDICULARS VESTIMENTI) AS A DISEASE CARRIER.

THE BODY LOUSE AS A CARRIER OF RELAPSING FEVER.

By Captain F. P. Mackie, I.M.S., on special duty for the investigation of Kala Azar.

The first record of the louse being suspected as a carrier of a specific disease dates from the publication of the observations made at Nasik [1] in August 1907 on an epidemic of Relapsing Fever.

The epidemiological feature of the outbreak was interesting and suggestive and gave an immediate clue as to the probable carrier which was borne out by further experiment.

The outbreak occurred in a mission settlement amongst a juvenile population.

The boys and girls occupied separate buildings well spaced from each other in a large compound—the sanitary arrangements, water-supply and food were all carefully supervised and the climate of Nasik is a very pleasant one situated as it is at the top of the *ghauts*.

The epidemic broke out about a month before I arrived and at the time was declining rapidly, so that the observations were lacking in some important directions. The disease broke out in the boys' ward and in about a month 137 out of 145 of the boys were struck down. The disease spread to the girls later and progressed very slowly and it is important to note that the first 15 girls to be attacked were all occupied in nursing the boys. Ultimately only 35 girls out of 115 suffered and the disease spread very slowly amongst them. Practically every relation or visitor to the boys' ward who came to nurse or sit with the sick boys contracted the disease whilst there was no such dangerous infectivity in the girls' ward.

All the boys occupied new buildings which were large, airy, and clean and gave no cover for bugs whilst the female wards were very old, dark and dilapidated and swarmed with bugs.

From the very first then the evidence was against the bed bug theory and in this I was not surprised for by the experience of eighteen months' experimental work in the transmission of Relapsing Fever [2] I had come to the conclusion that Cimex was not the true carrier of the disease. The epidemiological evidence was all in favour of the body louse as a carrier for these insects swarmed in the clothes and in the persons of the boys whilst the girls were practically free from them.

In the first fortnight despite the offer of rewards and the enthusiastic support of the mission people and of the children themselves only 29 body lice were found in the girls' ward but every day more came from the boys' ward than I could deal with.

The dissection of body lice was started at once and at the end of a fortnight 112 from the boys' ward were carefully dissected, of which 24·10 per cent. were more or less highly infected with spirilla. At this time 29 had been caught on the girls and only one of these was infected.

At the conclusion of my month's stay at Nasik, 14 per cent. of the boys' lice and 2·7 per cent. of those from the girls were found infected with spirilla.

Towards the end of the epidemic when the percentage of louse infection was falling rapidly, fifty-two lice were fed artificially (or given the opportunity to feed) on infected boys and of these 13.4 per cent. became infected. These fifty-two were not clean bred lice but were obtained from non-infected persons about the hospital. It should be stated that, not to my knowledge, has the body louse ever been shewn to be naturally infected with spirilla. I have examined many hundreds in various parts of India and have never found spirillum anywhere except amongst these Nasik lice. I have found at Nasik and in Bombay lice naturally infected with an Herpetomonas which has recently been described by Fantham as *Herpetomo as Pediculi.*

It is not necessary now to go minutely into the results of the dissection of infected lice but the series of lantern slides which I have prepared from my original drawings will give a good idea of the appearance of *Sp. Carteri* under various conditions including those seen in the louse dissections.

Lantern Slides.

List.

1. *Spirillum Carteri* (*Mackie*) from the blood of a human patient.
2. „ „ „ just before the crisis.
3. „ „ „ from a monkey.
4. „ „ „ „ „ just before the crisis.
5. „ „ „ from the stomach of an infected louse suggesting longitudinal division.
6. „ „ „ Stamed for flagella.
7. „ „ „ from cultures.
8. „ „ „ shewing spore like bodies.
9. „ „ „ „ „ (more advanced).
10. „ „ „ in renal cortex of a monkey.
11. „ „ „ „ a necrotic patch in the liver.
13. „ „ „ from alimentary canal of Pediculus Vestimenti.
14. „ „ „ „ mouth secration of
15. „ „ „ tissues of a young louse.
16. „ „ „ mouth parts of an infected louse.
17. „ „ „ stomach of a louse.
18. „ „ „ cloudy fluid from mouth parts of a louse.
19. „ „ „ cloudy shewing free spore like bodies.

} *from photo-micrographs.*

It appears therefore that the chief seat of multiplication is the alimentary canal of the louse. Primary multiplication takes place in the stomach and increases as the meal of blood is digested so that the heaviest infections are seen in hungry lice or those in which there are only the remains of blood to be found in the alimentary canal.

Later it is possible that the infection travels forward to the pharynx and mouth parts and at this stage an opalescent fluid can be obtained from the mouth parts, the opalescence being caused by the presence of swarms of active Spirochaetes in a fluid medium.

The question of salivary infection is unsettled, but I am inclined to think that it is the pharyngeal part of the canal which provides the nidus for infection.

Whether the ovary is infected or not is uncertain, but here again I am inclined to think that the generative organs are secondarily infected and by this means some sort of hereditary transmission is ensured, a process which seems probable in the case of so short lived an insect.

About 100 ova from the infected ward were examined but no spirilla were found. In view of Leishman's "infective granule" hypothesis the question of ova infection and hereditary transmission requires re-examination.

As regards the question of other possible carriers I examined large number of bugs from the girls' ward (and also some other insects) but though spirochaetes may be found and may even multiply a little in the stomach of the bed bug it is only in the presence of fresh blood and never results in anything but a scanty Infection which soon dies out.

I am more and more convinced that the Cimex transmission theory of Recurrent Fever is not the correct one and I believe that the body louse will be found to be the true transmitter of the spirochaetes in Europe as well as in India as it has already been proved by Sergent to be in the recurrent fever of Northern Africa.

I will now pass on to give the evidence of other workers for or against the louse transmission hypothesis.

My original paper was published in December 1907 and I received a communication a few weeks later from Dr. Ed. Sergent from Paris that he had independently come to the same conclusion.

I. His paper (with Dr. Foley) [3] was published in March 1908 and in it they stated that infected lice were obtained from an outbreak of Relapsing Fever on the Moroccan Frontier and that some were sent to Paris for examination.

A monkey inoculated with the broken up body of a single louse developed relapsing fever, but negative results were obtained with 18 bugs and 22 ticks (*Argas Persicus*) sent from the infected area. The epidemiological factors they state were also strongly in favour of the body louse.

II. As a side issue of the potentiality of the disease carrying power of lice reference may be made to Mantefel [4] and the rôle of the rat louse (*Hæmatopinus Spinulosus*) in the transmission of European recurrent fever.

Infected and clean rats were kept together and after six to eight days 47 per cent. of the clean rats became infected.

The disease was never transmitted in this way in the case of rats free from lice.

He also succeeded in infecting clean rats by putting them in cages with corpses of infected rats recently killed by ether, the lice left the dead rats and migrated to the healthy ones.

Mantefel affirms that the louse transmits the disease by biting the rats and it is not due to the lice being crushed or eaten or that the spirochaetes passes through the skin. He further states that the parasite does not escape by the alimentary canal with the fæces nor does the rat contract the disease by the alimentary tract.

Nothing was found in the eggs of infected lice. The louse remains infective for a very short time, for after 24 to 48 in a healthy rat the louse loses its power of infecting a third rat.

He tried to transmit *Spirochaeta Duttoni* by means of the rat louse from rat to rat, but had only one success in eight experiments. Similarly with the rat flea *Ceratophyllus Fasciatus* and *Spirochaeta Duttoni* where again he was successful once in eight experiments.

This experimenter then enters into a discussion on the possibility of the rat louse acting as a carrier of the human disease but concludes that it is improbable.

He points out that the *Hæmatopinus* is nearly related to human lice and he believes that by analogy the human relapsing fever of Europe is carried by human pediculines.

In reviewing this important paper in 1908 Professor Mesnil refers to my original paper in the Nasik epidemic and also to the first paper of Sergent and Foley, then but recently published, and concludes "this very plausible hypothesis deserves verification by further experiments."

The rat louse has also been proved by Prowazek and verified by Minchin and others to be interposed in the life cycle of *Trypanosoma Lewisi* of the rat.

Shellack [5] produced some negative evidence in favour of the louse hypothesis. He tried to transmit *Sp. Obermeiri* to the rat by means of *Argas Reflescus* and to the rat and to the monkey and to man by the intermediary of the bed bug. All the experiments were negative. He reviews the facts about transmission of relapsing fever and agrees that they are in favour of the hypothesis of louse transmission.

One of the most convincing papers yet published on this subject is that by Graham U. Smith [6] entitled "On some cases of Relapsing Fever in Egypt and the question of carriage by domestic vermin" published by John Bale Sons

and Daniel & Son, Limited, in 1909. He gives an account of a carefully conducted enquiry into an outbreak of Relapsing Fever in an Egyptian prison. He goes very minutely into all the epidemiological aspects of the disease, he writes p. 4. "From the result of the enquiry into the prevalence at Tura of external parasites usually regarded as possible or probable transmitters of Relapsing Fever namely ticks, bed bugs, body lice and fleas it may be concluded that one or other of the two last named only could have been instrumental in this instance."

He quotes Dr. Kirton who deals with epidemics at two of the Egyptian prisons who also came to the conclusion that the louse theory of communication furnished the most satisfactory explanation of the spread of the infection from prison to prison.

In all these three epidemics it appears that bugs were absent whilst body lice were present in greater or less numbers corresponding to the rapidity or otherwise of the spread of the disease.

Graham Smith then goes very fully into most of the past and recent history of outbreaks of relapsing fever dealing in a very careful and cautious way with all the epidemiological facts which tend to throw any light on the question of transmission.

He also quotes largely from my original papers and from those of Sergent and Foley already referred to and gives his own experience both experimental and clinical in support of his views.

On the whole his analysis of the question from all points of view leaves one almost convinced that all the evidence of epidemics in Europe and elsewhere both in past and in recent times points almost incontestibly to the body louse being the true carrier of relapsing fever and almost as strongly against the bug hypothesis.

He concludes by saying:—

> "Most of the arguments against bed bug conveyance are points in favour "of louse propagation, the most distinctive being the occurrence of "outbreaks where no other suctorial vermin existed. The tempor- "ary infectivity of clothing and the neutral behaviour of the infection "under the influence of climatic extremes
>
> "Relapsing Fever in Europe and in North Africa, India and Indo-China "is in all probability transmitted by body vermin (louse or flea) in "the act of feeding and the available evidence is as favourable to "Mackie's hypothesis as it is opposed to that of Tictin."

I sent miscroscopic specimens and copies of the papers to distinguished protozoologists on the continent and in America and received several answers verifying the accuracy of the obvervations. Professor Fraenkel of Halle wrote dated February 25th, 1908, "with the greatest interest I have read the publication you had the kindness to send me. I am indeed after your description quite persuaded that the louse is really the post and the transmitter of the spirilla and one of the most incomprehensible facts of the epidemiology of the recurrent fever will be explained by your discovery."

At a later date (1910) Sergent and Foley, [7] reported another outbreak of Algerian Relapsing Fever the cause of which they believe is a new species of spirochaete (*S. Berbera*). They came to the conclusion that it is carried by the body louse as they were able to transmit the disease in two cases to human beings by means of lice taken from the sick. On the other hand they examined Argasidæ, bugs, fleas and mosquitos and found no evidence that any of these could act as vectors.

Lemaire [8] worked with the Algerian disease of the same type as that studied by Sergent and Foley. He tried to transmit the disease by the bites of lice and by the injection of the bodies of lice but his experiments were negative. In July 1911 Sergent and Foley [9] return to the attack and record

another outbreak of Algerian recurrent fever. Here again the epidemiological facts were strongly against ticks and other insects but strongly in favour of body lice with which the patients were infested.

Nine monkeys were inoculated with lice taken from sick patients less than four days previously and of these nine, one became infected.

A further series of monkeys was inoculated from lice which had been kept more than four days after removal from the patient and four of these monkeys developed spirochætosis.

The infections in these monkeys were just as severe as in those inoculated with blood rich in spirilla the only difference being that the blood infected monkeys developed the disease in less than 24 hours whereas *those infected by lice developed relapsing fever in from 6 to 8 days which is the natural incubation period of the disease.*

It is strange to note that neither in this case nor in the records of any other observer but myself have spirilla ever been discovered in any numbers in the bodies of the lice, whether this is a peculiarity of the Indian disease or whether the temperature and other conditions of Nasik were particularly propitious I cannot say.

The discoveries of *Leishman* [10] on the phenomenon of the "infective granule" in *Spirochaeta Duttoni* and *Ornithodorus Moubata* may explain this. He found that the Spirochaetes generally disappeared from the tissues of the tick after an infected feed, but yet the arthropod remained infective.

He found that by raising the temperature of the ticks to approximate mammalial blood heat, there was a reappearance of spirochaetes in its tissues, and so he concludes that the granules in the tick represent a resting stage and when the granule-containing fluid is injected into the appropriate warm blooded animal the spirilla so to speak hatch out and reserve their normal blood form. If this applies to Spirochaetes in lice it explains why so many good observers have failed to find the parasites in the bodies of infected lice and raises the question why they were so obvious and unmistakable in the lice at Nasik.

BAYON. [11] (Parasitology, June 1912), 'studied an epidemic of Relapsing Fever in Moscow and he found that in the infected quarters *Cimex* was absent but P. Vestimenti swarmed. He concludes on clinical epidemiological grounds:—

> "From what I have seen in Moscow I am of opinion that the transmission of relapsing fever in Russia is commonly effected by Pediculus Vestumentorum and not by Cimex."

He quotes Fehrmann [12] (the original paper I have not seen) who came to the conclusion in 1910 on epidemiological and clinical grounds that recurrent fever in St. Petersburg was being carried by body lice.

The Body Louse and Typhus Fever.

Those who have experienced epidemics of relapsing and typhus fever must have been struck with the close similarity of the epidemiological conditions under which these two diseases occur.

In my original paper I said with reference to Relapsing feuer that "it has "always been associated with poverty-stricken, over-crowded and half-starved "communities and it is under just such conditions that lousiness is at its worst. "Again in mixed communities, as in Bombay, the disease attacks the poor, dirty "and low caste living in squalid tenements to the exclusion of those of cleanly "habits and better conditions of life.

"Relapsing fever is a 'personal' and not a 'place' disease, and amongst "stricken communities the infection spreads from person to person very rapidly "after only a few days exposure and mere contiguity without contact is not suffi-"cient to carry in the infection."

These remarks are applicable in every particular to Typhus fever and I was strongly of opinion that the latter disease was also louse borne and it is a lasting regret to me that I was not able to apply myself to the problem of Typhus fever.

However this has been done to old world Typhus by Nicolle—

(Compt. Rend. Accd. Sc., July 12th, 1909)

(Compt. Rend. Accd. Sc., September 6th, 1909)

and to Mexican Typhus or tabardillo by Anderson and Goldberger (Pub. Health Department, December 24th, 1909,) and by Rickets and Wilder.

In the Journal American Medical Association,

February 5th, 1910, page 463.

do. April 16th, 1910, page 1304,

„ July 23rd, 1910, page 309.

The results of these researches goes to prove that typhus fever both of the old and new world is a louse borne disease. I will here summarise briefly some of the conclusions to which these investigators arrived.

Nicolle and his associates were the first to shew that typhus fever was transmissible from man to chimpanzee and from the chimpanzee to *Macacus Sinicus* by the injection of infected blood.

This part of their work does not concern us now except that they found that *M. Sinicus* could not be inoculated directly from man and that in any case considerable quantities of blood were necessary to ensure a successful transmission from man to the anthropoid and thence to the monkey. Their results differ somewhat from those of Anderson and Goldberger and of Ricketts and Wilder who found that *Macacus Rhesus* and a capuchin could be directly inoculated from man, a fact which suggests that the diseases are not exactly identical though they are certainly closely related. We may recall similar discrepancies in the Relapsing Fever of different parts of the world. Cultivation of the blood in all instances proved negative in the hands of all these observers but Ricketts and Wilder found the virus was stopped by filtration, *i. e.*, it is not a "filter passer."

Nicolle first succeeded in transmitting typhus from a chimpanzee to a macacus monkey through the bite of the louse (P. Vestimenti). He used 29 lice which fed first in the anthropoid and then on the macacus for several successive days. It is interesting to note that according to Ricketts and Wilder the minimum infective dose of blood injected by a syringe is between 0·2 and 1·0 for the monkey. In his successful louse transmission it is certain that the amount of blood injected was very much less than 0·2 c.c., I have pointed out the same in relapsing fever that the blood dose necessary to infect a monkey is much in excess of that injected by the intermediate host. This points in both cases to specific and not casual infection of the body louse.

Ricketts and Wilder sum up their first two papers as follows:—

I. It seems that *Macacus Rhesus* can be infected with tabardillo invariably by the injection of virulent blood from man taken on the 8th, 10th day of fever. The blood should be diluted with salt solution.

II. Attempts to maintain typhus in the monkey by passage through other monkeys were not successful.

III. The monkey may pass through an attack of typhus so mild that it cannot be recognised clinically. Vaccination results.

IV. The immunity test is a reliable proof of the previous occurrence in non-occurrence of typhus at least within a period of a month.

V. Typhus was transmitted to the monkey by the bite of the louse in two experiments, the lice in one instance deriving their infection from man and in another from the monkey.

VI. Another monkey was infected by typhus through the introduction of the fæces and abdominal contents of infected lice into small incisions. Other experiments, in which the immunity tests have not been given, corroborate the carrying power of the louse.

In their third paper, July 1910, Ricketts and Wilder—examine the question of hereditary transmission in lice and bring some evidence to shew that this does occur.

They then discuss the epidemiological and experimental evidence for or against other insect carriers (bugs and fleas) in typhus and conclude that there is no reason whatever to suspect either of these insects as playing any part in the transmission.

The bionomics of the body louse.

I do not propose going at all minutely into the anatomy of the louse as it does not concern us as hygienists and moreover their general naked eye appearances and particularly their habits serve to differentiate them easily from head lice (P. Capitis) and other personal vermin. Apparently entomologists find some difficulty in differentiating the head and body lice anatomically, for Neumann (Archives de Parasitology, Volume 14) concludes that the body louse is a sub-species of the head louse and not a distinct species. The following lantern slides shew better than any description the principal points of interest.

I. External anatomy of the body louse.

II. Alimentary canal and appendages.

III. Generative organs of the body louse.

VI. Herpetomonas Vestimenti Fantham.

It is generally easy to distinguish between the head and body lice even apart from their strictly maintained habitat.

Body lice are pale or dirty white colour, head lice in this country are dark or black in colour and some shew a dark ventro thoracic shield which I have never seen in P. Vestimenti. The legs of the body louse are longer and less curved and white in colour differing in all these particulars from the other species.

The female body louse is nearly twice as large as the adult male but there is little disparity in size of the sexes in the head louse

The former lays glistening white eggs in the recesses and seams of the clothing whilst the nits of the head louse are glued to the hairs.

The stomach of the body louse seen with a hand lens is very obvious from the ventral surface as a bicornuate pulsating organ but this is not so in the head louse whose exo-skeleton seems tougher and more chitinous and therefore more opaque. I may add here that I found no evidence to incriminate the head louse in Relapsing Fever nor apparently has any one else.

I examined over 100 head lice from infected boys and girls at Nasik and found nothing, indeed I doubted whether they ever suck blood as in none of these did I find blood or its remains but only a greasy sebaceous material which they doubtless get from the skin of the scalp. (I am probably wrong about this as Patton tells us he has found blood in head lice, but I can only record my own experience.)

Warburton, (1909 Local Government Board Reports: London) and more recently Fantham, (Proceedings Royal Society B., Volume 84, 1912,) have written on the habits of the body louse and the following description is taken from their papers modified by my own experience in Nasik, Bombay and Madras. Lice are best kept in tubes on small pieces of flannel or cloth in the dark or subdued light as they succumb quickly to sun light. The eggs are found firmly glued to the fabric and if removed must be cut away with fine scissors. The eggs take from a few days to a few weeks to hatch out and this does not seem entirely to depend on the temperature.

In India both eggs and adults do best in a cool incubator. The larvæ are tiny white and very active creatures which feed at once if placed on the back of the hand, they turn red with blood in three or four minutes. Moulting occurs every few days.

The imaginal stage is attained in about eleven to twelve days after hatching, sexual maturity about four days later. (Fantham).

Copulation is curious and explains the functions of the secondary sexual appendages. If watched under a low power the male is seen to creep beneath the female and lock his first pair of claspers firmly round the base of the anterior, middle and posterior pan of the females' legs depending on the relative size of the two insects. The penis is protruded and then strongly retroverted and along its sheath is a densely ribbed chitinous plate. This is powerfully grasped by a pair of chitinous claspers situated in the ventral surface of the female. A rythmical peristalsis of the internal organs follow accompanied by the passage of sperm packets. The free males when in an excited condition may be seen running actively about with their post extremities raised and retroverted like those of scorpions. Egg laying is at the rate of a few days and sometimes throughout the life of the female.

Warburton found that the life of the male was about three weeks and that of the female a week longer. I find they do not often live as long as that in India but generally about 7 to 10 days but I have not fed them twice a day as Warburton states is necessary to keep them in perfect health. Under ordinary conditions the mortality amongst them is very high, sometimes a whole batch will die in a few days or in a single night for no known reason; unless they are fed at least once daily they die off very quickly. It is easy to feed them, the pieces of cloth should be placed on the skin and the insects lifted off one by one placed on the bare skin. They settle down at once and begin to suck, the stab is not felt by the patient; as they fill themselves the abdomen is raised from the skin till at the end of the process the louse is standing on its head vertically. When full they leave go and make for cover.

I pointed out in my Nasik paper how they transfer themselves from one piece of cloth to another when these are brushed together and this is very marked when they are feeding, for if a piece of cloth is passed over them every louse, in whatever stage of feeding, at once clings to the passing cloth. This is of interest in shewing how one person can transfer infection to another by casual contact.

The paper referred to by Fantham deals with a natural parasite of the body louse which he names Herpetomonas Vestimenti (Nov. Spec.)

I first saw and referred to this parasite in my original paper (British Medical Journal, December 14th, 1907) where I, in ignorance, called them Crithidia. I did not however describe them accurately and the credit therefore rightly belongs to Fantham. The presence of this flagellate must be remembered by those investigating the disease carrying power of the louse especially in Kala Azar. In Madras last May I fed 279 body lice on patients suffering from Kala Azar who had *Lieshmania Donovani* in their peripheral blood. On subsequently dissecting these at different intervals I failed to find flagellates of any sort.

The habits of the louse make it one of the easiest of all blood sucking parasites to eradicate.

Personal cleanliness, the disinfection and even plain washing of clothes is sufficient to kill them especially if the garments are afterwards exposed to the sun to dry. I have made no experiments on the resistance of eggs, but I believe this is not great. Warburton says eggs may live a month and be transmitted to a distance in clothing.

It is probable that the isolation of patients together with the disinfection of clothes and bedding and the avoidance of actual contract (such as sitting on beds) will suffice to cut short epidemics both of relapsing fever and of Typhus.

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REPORT

OF

THE MANAGING COMMITTEE

OF

THE BOMBAY CENTRAL FAMINE RELIEF FUND

(Organised for relief principally in Gujerat, Cutch and Kathiawar.)

1911-12.

The following is an extract from the minutes of the final meeting of the Managing Committee of the Bombay Central Famine Relief Fund held on 10*th October* 1912 :—

The Chairman read the following letter from the General Secretary :—

89, Apollo Street, Fort,
Bombay, 10*th October* 1912.

To,

The Chairman of the Meeting of the Managing Committee of the Bombay Central Famine Relief Fund to be held on 10th October 1912.

Dear Sir,

I have pleasure in submitting herewith my draft of the report of the Managing Committee as desired at the last meeting.

A few accounts still remain unsettled. I do not however expect any great alteration in the accounts ultimately.

My best thanks are due to all those members who have been good enough to attend the meetings regularly to help in the deliberations. I beg to tender my specially grateful thanks to the Hon'ble Mr. Armstrong and Mr. Glazebrook who have most willingly advised and guided me in the administration of this Fund.

The late lamented Mr. Dharamsey Morarji Gokuldas, before he left for Mahableshwar, had assisted me to get donations to this Fund and had he been spared to return to Bombay, would, I am sure, have been very useful in collections. In fact we greatly missed his genial personality at the meetings.

Messrs. K. M. Javeri and L. A. Shah very kindly undertook collections in the Small Causes Court, and, High Court, respectively, which fetched handsome sums.

Mr. G. K. Deodhar, in the midst of his multifarious charitable activities, had always been a willing fellow-worker till March, when he left for Bhopal. In his absence Mr. Vaikunth Lallubhai Samaldas kindly assisted me in his usual quiet and modest way. I beg to heartily thank both of these gentlemen for their kind assistance.

Mr. Nagindas Damoderdas has worked as Honorary Cashier to the Fund and deserves my best appreciation for his efficient handling of the Fund's cash, turnover, wherein, amounts to close upon Rs. 8,00,000.

Yours truly,
PURSHOTAMDAS THAKURDAS,
Honorary General Secretary and Treasurer,
Bombay Central Famine Relief Fund.

Resolved : " That the report be adopted and that the same, together with the final accounts, be published for the information of the public."

The Hon'ble Sir Vithaldas Damodar Thackersey, Kt., proposed, and the Hon'ble Mr. Goculdas K. Parekh seconded, that—

> " The Committee of the Bombay Central Famine Relief Fund have great pleasure in putting on record their high appreciation of the energetic, efficient and patient manner in which Mr. Purshotamdas Thakurdas did, with conspicuous ability, and, at great personal sacrifice, the work of Honorary General Secretary and Treasurer of this Fund for a period of nearly one year with entire satisfaction of all concerned, and, they take this opportunity of tendering to him the best thanks of this Committee for the most willing and excellent service rendered by him to this Fund ; that this resolution be incorporated in the report of the Fund to be published hereafter. "

Carried with acclamation.

C. H. ARMSTRONG,
Chairman of the Meeting.

THE BOMBAY CENTRAL FAMINE RELIEF FUND.

REPORT OF THE MANAGING COMMITTEE.

Owing to the almost complete failure of rains* after June 1911 a large and important part of the Bombay Presidency was overtaken by famine and scarcity. The distress was severe especially in Kathiawar, Cutch, Gujerath, Mahi Kantha, Kaira and Punch Mahals. Though it was not acute in the latter part of 1911 amongst the inhabitants of the affected areas, the cattle suffered severely from want of fodder and water, and it was feared that later on the poorer classes there might require liberal assistance to enable them to tide over the bad times and give a fresh start in life. Government had introduced the usual Relief measures under the Famine Code, but, from evidence collected in the famine-stricken districts, it was clear that in addition to what Government were doing, considerable non-official relief was necessary, and Government would welcome the help of Private Charity to supplement their efforts in relieving the distress in the affected areas. With this object in view the Hon'ble Mr. Parekh, assisted by Messrs. Deodhar and Joshi of the Servants of India Society, arranged for a meeting of leading citizens of Bombay on 30th October 1911. Mr. G. K. Deodhar, who had just returned from his tour in some of the affected areas, gave the meeting an idea of the needs of the situation, and told them how Government officials and the public outside were willing to co-operate with a Central Famine Relief Committee, if one was formed. An influential Committee was appointed, and it was decided to start a Central Famine Relief Fund and to appeal to the Public for support.

The objects of the Fund were as under :—

(1) To supplement the Government measures of relief (with the co-operation of local committees and local officials) by taking such steps in saving the cattle as may be found useful and practicable.

(2) To supplement the efforts made by Government in mitigating human suffering by organising relief with their co-operation and also to adopt such measures as may be deemed necessary to relieve the distress of poor agriculturists and other famine-stricken people.

(3) To collect funds for the purpose of organising and distributing private relief in the affected areas of this Presidency.

(4) To secure Volunteer workers and assistance of local committees in promoting the object of this Fund.

(5) To take such other steps as may be thought necessary in furtherance of the end in view.

* Appendix A gives a comparative statement of rainfall in some of the affected areas.

The Committee's scheme of relief was as follows :—

1. Cattle Relief—

   (*a*) Cattle Camps.

   (*b*) Cattle Kitchens.

   (*c*) Cheap fodder shops.

   (*d*) Distribution of fodder.

   (*e*) Deporting cattle to jungles, etc., etc.

   (*f*) Supplying hay at cost price to those who in the affected areas undertook to use same for cattle camps or cattle kitchens, or sell it at a loss to deserving persons for their cattle.

8. Human Relief—

   (*a*) Gratuitous relief to the respectable poor not receiving outside help.

   (*b*) Distribution of clothing to the people on Relief Works.

   (*c*) Provision of some necessaries of life to those on the Relief Works.

   (*d*) Cheap grain shops in places severely affected by scarcity.

   (*e*) Help to orphans, widows and destitute and decrepit persons not in receipt of any other relief.

   (*f*) Distribution of valedictory dole to those agriculturists who receive no Tagavi from Government to enable them to start their agricultural operations at the beginning of the next monsoon.

Subscriptions were accepted earmarked for any of the above objects if so desired by subscribers.

Appendix B contains a list of the members of the Managing Committee and other Office-bearers of the Fund. The Managing Committee held their meetings regularly once a week, which number 37 in all.

3. Towards the end of February 1912 distress to the cattle got very keen, and a requisition, signed by the leading citizens of Bombay, of all communities, was sent to Mr. Narottam Morarji Gokuldas, Sheriff of Bombay, to call a Public Meeting of the citizens of Bombay to consider " What steps may best be taken to assist the Managing Committee of the Bombay Central Famine Relief Fund in their efforts to alleviate the distress amongst individuals and cattle in the affected areas."

His Excellency Sir George Clarke, Governor of Bombay, kindly consented to preside at such a meeting called at the Town Hall on 19th March 1912. About Rs. 15,000 were announced as donations on the spot, and the meeting was a very successful gathering attracting general sympathy of Bombay Presidency as a whole to the affected areas. (Appendix C gives proceedings of the said meeting.)

4. *Funds.*—Before this Fund was started representatives of various Mahajans, Pinjrapoles and Gau Shalas from the affected areas had been busy taking round subscription lists in Bombay for cattle relief. These lists got good support from the Bombay public and especially from inhabitants of the affected areas who had settled in Bombay for business purposes. Besides this, the following bodies had commenced distribution of funds available from accumulations in their Associations, or raised by special cesses, on commodities, in which their members dealt. The following Institutions and Associations gave money for relief purposes out of accumulated funds :—

(1) Bombay Pinjrapole, Rs. 40,000.

(2) Native Piece-goods Merchants' Association, Rs. 80,000.

(3) Pearl Merchants' Charities Scale, Rs. 60,000.

(4) Bombay Gaurakshak Mandali, Rs. 10,000.

The following Associations gave money from special cesses levied for famine relief purposes :—

(1) Bombay Grain Merchants' Association (the cess being Rs. 1-8 0 per 100 bags of grain sold in the Grain Market at Mandvi and Re. 0-1-6 per Candy in grains sold by measurement), total distribution being Rs. 50,786.

(2) Condiment Merchants' Association (the cess being on several articles of paint and condiments), Rs. 1,30,000 about.

Besides, the Wadia Trustees had resolved to spend Rs. 1,00,000 for relief of famine distress, and Mr. Narottam Morarji Goculdas started on 13th January 1912 a "Two Annas Famine Fund" which amounted to Rs. 78,000.

Owing to the Royal visit, the work of collecting funds on behalf of this Committee was somewhat delayed, and the Committee had to requisition the assistance of the Indian Peoples' Famine Trust, Calcutta, to allow them to commence their operations of relief on a basis in keeping with the magnitude of distress. The appeal of the Committee was met by the Trustees of the Indian Peoples' Famine Fund on 6th January, 1912, with a munificent donation of Rs. 50,000, and this sum may be said to be solely responsible for the free hand that the Managing Committee got at the commencement in giving relief. Subsequently, Rs. 1,00,000 more were voted by the Indian Peoples' Famine Fund Trust, in two more instalments, and Appendix D gives a complete list of subscribers to this Fund. The Managing Committee desire to tender their best thanks to the Trustees of the Indian Peoples' Famine Trust, Calcutta, and all the generous contributors to this Fund, and trust that their mentioning the following donations here will not be looked upon as an invidious distinction :—

Rs.	500	0	0	His Excellency Sir George Sydenham Clarke, Governor of Bombay.
,,	19,282	3	0	Remitted by Mr. Ichharam Suryaram Desai, Proprietor and Editor of "The Gujerati" (being collection in "One Anna Fund" in the columns of "The Gujerati").

Rs.	19,025	0	0	From the Social Service League, Bombay (by a house-to-house collection in Bombay and suburbs).
„	16,951	3	0	Being collection by, and through, the Servants of India Society in various parts of India.
„	9,000	0	0	(about) were collected in June 1912 on the occasion of the Hindu "Purshottam" month by calling attention of the Hindus, by means of handbills, to the pitiable state of cattle in the affected areas, and offering to save from starvation till the end of July 1912 one cow for every Rs. 12 paid to the Managing Committee. Their Holinesses Maharaj Shree Tikayat Shree Gordhanlaljee of Nath Dwara and Maharaj Shree Gocul Nathjee of Bombay were pleased to give respectively Rs. 1,000 and Rs. 525 towards this collection, and this was followed by general sympathy of Hindus as a whole to the collection.

Very generous contributions amounting to Rs. 10,000 were received from Mr. Ratan Tata, Rs. 6,000 from Lala Lajpatrai from the balance in his hands of the famine fund of 1908, Rs. 5,000 each from His Highness the Nizam, His Highness Sir Bhagavatsingji, G.C.I.E., Thakore Saheb of Gondal, Miss Hamabai F. Petit, and Rs. 4,000 from Mrs. Jamnabai N. Sakkai's collection. The total amount collected from all sources will be seen from Appendix "D."

5. *Cattle Relief.*—Before the Fund was started, many officers from the affected areas had written to several of the prominent office-bearers of this Committee inquiring whether Bombay would not extend her help to the affected areas during the distress. Immediately, therefore, after the formation of the Committee, the General Secretary placed himself in touch with such officers. It was found that the greatest need was of fodder being made available to the cattle in the affected areas at about normal rates. In some cases the officers advocated starting cattle camps or kitchens for preservation of plough cattle. The Committee voted grants for losses to be borne by sale of cheap fodder, and in cases of cattle—kitchens and camps, free fodder grants were voted.

Col. H. D. Merewether, Political Agent, Palanpur, called for cash remittances in case of all such grants, for he had in his districts, which are distant from Railway Lines, hay available at reasonable rates. The Mahajans in Cutch also called for cash remittances for the same reason. Barring these two, practically the whole of the affected areas applied for hay despatches to work off this Committee's grants

The Delhi Durbar, an unusually pressing demand for coal for Railway purposes in the first few months of 1912, and a large demand for rolling stock

to move the export trade from other parts of India, all combined to make this period a time of "wagon famine" in conjunction with a fodder famine. Government officials and private individuals, together with managers of charitable institutions, in the affected areas, all uniformly complained that in spite of their having purchased hay at various places, they were not able to import same in their own districts owing to wagons not being available. Many of the Dewans of Native States wrote touchingly asking this Committee's help to supply fodder at cost price.

The Railways had since 1st August 1911 introduced half rates for carriage of hay, *viz.*, two annas to two annas and six pies per wagon of hay per mile to the affected areas. The Government had offered concession on 1st October 1911 bringing the freight on wagon load of hay to the affected areas down to six pies per mile. In issuing the Press note, dated 20th September 1911, notifying their concession the Government of India had expressed a hope that the same would stimulate private venture in the importation of hay into the affected areas. As the concession was made available without any distinction to all who chose to send hay into the affected areas, and, as the wagon supply by the Railway Companies concerned grew smaller, the ventures of private dealers, who imported hay with the intention of making a profit, increased. Under such circumstances this Committee offered the General Traffic Manager, B. B. & C. I. Railway, that they would utilise wagons, placed at their disposal, for carrying hay to the affected areas,for supply of same at cost price or at reduced rates only. This Committee's hay was lying purchased at Bamania, Amargarh and Bajarangarh on Godhra-Rutlam Section of the B. B. & C. I. Railway Line and at stations between Palghar and Balsar. The B. B. & C. I. Railway Company began giving about ten wagons a day from stations between Palghar and Balsar for carrying hay to Kathiawar and Gujrath, and special trains on the Godhra-Rutlam Line for carrying hay to the Kaira District. This supply of hay was distributed by the Managing Committee according to the needs of the several officers, individuals, and charitable institutions in the affected areas. Every one of the applicants for hay was requested to send in his requirements of quantity of hay per month, and the General Secretary took all possible care to see that no station in pressing need of hay was being starved for hay at the expense of any other that might be importing same with the object of laying in even small stock. Government are entitled to the best thanks of the people for the liberal concession, and on future occasions nothing will help famine areas so much as a freight concession being made available.

The Managing Committee have no hesitation in saying that their system of supply of hay has been keenly appreciated. Many of the indenters of the Committee's hay have assured the Committee that were it not for the regular supply of hay from this Committee their schemes of relief would have had to be given up ; in several cases the Committee's hay is reported to have saved the position at many kitchens and camps, and from reports received from all in the affected areas, there is no doubt that this Committee's hay-supplying operations have been the means of very considerable relief being afforded all round. Mr. H. L. Painter, I.C.S., Collector of Ahmedabad, and Chairman of

the Ahmedabad Famine Relief Committee, was given a first grant of Rs. 12,500 which was to be given in the form of free hay. On 15th April 1912 the Collector wired as under :—

"Have you despatched any grass as yet or must I close the kitchens."

The Committee are glad to report that in reply to the above hay was commenced to be despatched from 16th April, and by the 25th of April the Committee had posted to the Collector Railway Receipts for 625,000 lbs. of hay, thus preventing a breakdown in the Ahmedabad Cattle Kitchen. Appendix E gives the quantities of hay moved to various stations against Cheap Hay Grants, Free Gifts and Cost Price indents.

All the hay was insured against loss by fire in transit. At stations between Palghar and Surat the hay lying in station yards was insured also. A charge of two annas per 1,000 lbs. was levied from those who imported hay at cost price, and in July one anna and six pies per 1,000 lbs. were refunded, as the average cost on the total quantity moved did not come to more than six pies. There were no casualties during transit, but two fires took place at exporting stations in wagons immediately after they were loaded, the cause of the accidents being sparks from passing engines before the hay could be covered with sheets. The claims on this account, amounting to Rs. 272-8-0, were duly recovered from the Insurance Companies concerned.

6. *Supply of wagons.*—The Managing Committee commenced with a supply of ten wagons a day at stations near Bombay and are glad to report that the General Traffic Manager increased this supply to 35 wagons a day towards the end of June 1912, when demand of hay was most pressing and piteous. Besides this, when circumstances permitted, specials were given to this Committee on the Tapti-Valley Line and latterly on the Main Line, too, despatches on the two lines amounting to two crores and eighty-eight lakhs of lbs.

On the Godhra-Rutlam Section particularly, all hay, amounting to about 56 lakhs, was moved by specials and Mr. S. G. Gogate, of the Servants of India Society, rendered signal service in buying with the assistance of Mr. A. Chuckerbutty, Collector of Kaira, 50 lakhs of lbs. from the Indore State at Rs. 11 per 1,000 lbs. and loading the specials under circumstances which might have baffled the patience of a less devoted, persevering and tactful person. It may be added that besides moving 50 lakhs of lbs. of hay for the Committee, Mr. Gogate helped both the Government and local merchants there to move their hay also to the extent of a crore of lbs. of hay.

About 6 lakhs of lbs. of hay were bought through the Servants of India Society at Markundi, Bhopal, Datia, Dabourah costing less than Rs. 10 per 1,000 lbs. at Ahmedabad, but, owing to inadequate wagon supply at these stations, it was not found possible to move more than 388,128 lbs. of this hay.

As has been mentioned above a number of private funds were being administered from Bombay for relief in the affected areas. The Managers of these funds, especially the Bombay Pinjrapole, the Gaurakshak Mandali, Piecegoods Merchants' Association, Condiment Merchants' Association and Mr. Narottam Morarji Goculdas from time to time applied to the Committee for

assistance by way of despatch of hay at cost price on their account, and the General Secretary attended to their applications as promptly as circumstances permitted. None who applied for hay to be sent at cost price on his account was refused that facility, in fact every one's indent has been fully attended to.

7. *Advancing rates of hay.*—The Managing Committee bought hay on B. B. & C. I. Railway stations at Rs. 11, and paid steadily upto Rs. 20-8-0 per 1,000 lbs. The reason why more could not be bought at lower rates, say between Rs. 11 and Rs. 15, is, that there was no certainty of a steady wagon supply at particular stations. In fact, the Committee bought hay wherever it suited the Railways to give them wagons. Again, buying hay in large quantities would have meant locking up that much cash which also the Committee could hardly afford ; it would have meant weighing over and storing the hay and hence taking the risk of damage by fire or water at hay despatching stations. The despatches per day were limited, and hay merchants would not wait beyond a certain period for proceeds of their stocks; especially in a rising market. Under these circumstances the Managing Committee decided to buy in anticipation of a week or fortnight's despatches only.

Mr. Tribhovandas Gandabhai, of Umbergaon, doing hay business on commission was engaged by this Committee on a commission of four annas per 1,000 lbs. and net out-of-pocket expenses for carting and loading, to buy and despatch hay per the General Secretary's instructions. The total quantity bought and loaded by him for the Committee amounts to lbs. two crores and eighty-eight lakhs in all, at an average cost of Rs. 16·25 including charges of about Re. 0-8-0 per 1,000 lbs. The Managing Committee desire to express their satisfaction at the work done by Mr. Tribhovandas, whom they found straightforward in dealings and prompt and energetic in despatch.

8. *Loss of bales and weight during transit of hay.*—The Managing Committee had made it a rule to ask importers to accept their Agent's Invoice Weights and number of bales; whoever wished to assure himself better was allowed to send his representative to the hay-despatching-stations to superintend the operations. Loss in hand-pressed bales during transit may be taken on an average to be 3 to 5 per cent. Many of the importers however complained of a bigger loss especially those whose stations required hay to be transferred *en route* from Broad-gauge to Narrow-gauge wagons. At some of such importing stations, the Committee found that old and defective scales were used to check this Committee's weights and hence weights at destination were not uniformly reliable.

To check the consignments at the most important of such junctions, *viz.*, Viramgaum, the Kathiawar Central Famine Relief Committee had posted a special clerk to superintend all transhipments of hay sent by this Committee, but the said clerk reported that loading and unloading of wagons used very often to be done at night and " there was such stress of work that neither he nor the Railway authorities could possibly count the exact number of bales that were received, nor could they do so when re-booked in transhipment as the greater part of the work of transhipment was done at night." It is thus

that the Managing Committee account for smaller number of bales than actually consigned being delivered to some of the consignees. The Railway Companies refused to entertain claims for loss of bales or in weight, as they maintained they could take no responsibilities owing to the special mileage-rate having been quoted.

9. *Cottonseed Husks.*—For places where it was not possible to send hay for cattle, owing to their being distant from Railway stations, towards the end of May 1912, when demand for fodder increased, the Committee despatched Cottonseed Husks, a nutritive food for the cattle, and a partial substitute for hay. A large quantity of these husks have been sent to Cutch, Mandvi and Anjar and to several places in the Daskroi Taluka of Gujarat. Everywhere the husks were found to be useful. At Cutch Mandvi Rs. 3000 were given to the Mahajan for loss on sale of cotton-seed-husks, which were sold at a loss of 33 per cent. Thus husks worth Rs. 9,000 were sold there at a loss of Rs. 3,000.

The cost of these husks was between Rs. 6-14-0 and Rs. 8-0-0 per 784 lbs., but Railway Freight was found to be prohibitively high, and, on the facts being brought to the notice of Mr. F. W. Hanson, the General Traffic Manager, B. B. & C. I. Railway, a special rate was allowed upto end of July 1912. About 800,000 lbs. of husks were sent in all, the major part having been bought from the Jamsed Oil Mill Co., Ltd., at Kurla.

10. The Managing Committee desire here to record their most sincere appreciations of the many numerous facilities afforded to them by the B. B. & C. I. Railway in the work of despatch of fodder to the affected areas. Whilst no one can deny the inadequacy of Railway facilities for transport purposes during a period of unforeseen and abnormal circumstances, and taking into consideration the great scarcity of water even for Railway purposes on the Godhra-Rutlam Section from where 60 lakhs of lbs. of hay were despatched, it must be recorded that the very sympathetic manner in which Mr. F. W. Hanson, the General Traffic Manager, B. B. & C. I. Railway, attended to all the demands of this Committee has greatly assisted the affected areas in being supplied with as much fodder as was feasible under very trying circumstances. By a special resolution of the Managing Committee, their best thanks have been conveyed to Mr. F. W. Hanson, General Traffic Manager, B. B. & C. I. Railway, for his valuable assistance.

11. The total quantity of hay carried to the affected areas by rail from 1st November 1911 to 30th June 1912 is 47,749 wagon-loads, containing about 45 crores of lbs. of hay. Of this, 39,940 wagons were despatched from stations on the B. B. & C. I. Railway, and 7,809 wagons from stations on the other Railways. Of this total quantity, 4,709 wagon-loads carrying 4 crores of lbs. of hay were transhipped at Viramgaum from 1st January 1912 to 30th June 1912 for Kathiawar, of which more than $1\frac{3}{4}$ crores were sent by this Committee; besides which the Bhawnagar Famine Relief Committee imported lbs. 2,086,512 by sea on their own account.

The B. B. & C. I. Railway carried 39,940 wagon-loads as under :—

Month.	No. of wagons.
November 1911	1,913
December „	2,710
January 1912	4,370
February „	5,217
March „	6,096
April „	7,487
May „	7,863
June „	4,284
	39,940

It will be seen that the bulk of the hay traffic was tendered in increasing quantities from month to month since November 1911. The B. B. & C. I. Railway maintain that had the hay-moving-operations of all concerned commenced on a large scale in October 1911, immediately after hay was harvested, the pressure for traffic on the Railway Line would have considerably fallen off from February onwards, when produce and cotton traffic demanded their attention. Besides this, the Railways would have been able to move a much larger quantity of hay with considerably less strain to those responsible for cattle relief operations. The reduced rates of freight on hay available from 1st August 1911, and the Government concession from 1st October, cost the B. B. & C. I. Railway alone more than Rs. 10 lakhs, and the Government about Rs. 12 lakhs.

12. *Human Relief.*—Human distress by famine was recognised by the Government in the Punch Mahals, where Relief Works had been opened. The monthly reports of the Collector, Panch Mahals, to the Bombay Government, have been satisfactory, stating the condition of the men on Relief Works as normal. To provide additional small comfort to the women and children on these works, 400 blankets were sent to the Panch Mahals during the winter of 1911.

But the greatest need for relief of human suffering was of help to the respectable poor who could not beg nor go on the Relief Works. For such, a good deal of money was placed at the disposal of the Government Officials in Kaira, Panch Mahals and Palanpur. Rates of grain were higher than in the preceding five years by 40 to 80 per cent.; to those who earned a livelihood by petty cultivation and some sort of service during the season months of the District, the sources of maintenance failed this year in the affected areas. To provide for these appeared to the Managing Committee to be necessary. Much of such relief work had to be done in Cutch through the Mahajans there and liberal grants were given from time to time for this purpose.

Cheap grain shops have been included in the scheme of relief of this Committee; but all the officers in the affected areas pronounced this mode as being undesirable, as it required most careful watching and supervision. This was, therefore, given up at the commencement and was adopted later on for relief through the Salvation Army only, who offered to execute same satisfactorily.

A good deal of clothing was supplied to the persons on Relief Works in the Panch Mahals in May and June when the need was pronounced to be very great. Generous persons offered the Committee old high class clothing for the poor and the needy. This was accepted and sent to places where respectable poor were being assisted. In cases where the clothing was found to be unsuitable to the people, it was sold off and the proceeds used to buy new clothing of the required quality.

To help Pardanashin women in Districts of the Palanpur Agency, the Managing Committee requested Mrs. Ramabai Ranade, President, Seva Sadan Society, Poona, to visit the Palanpur Agency Thanas with a few Lady Volunteers. The invitation was readily accepted and the Political Agent, Palanpur, reports that Mrs. Ramabai and party were very helpful in giving relief to Pardanashin women (inaccessible to male members of the Local Committee) there in a satisfactory manner. The Managing Committee's thanks have been duly conveyed to Mrs. Ranade and party.

13. *Wells.*—Benefitting by past experience, officers in charge of several Districts in the affected areas had, since September 1911, arranged for sinking of wells as a means of self-help to the people. However, in Kaira District, there was a great scarcity of water reported, and at the request of the Collector the Managing Committee sanctioned Rs. 2,000 for Cutcha wells.

The Collector's report shows that 28 wells were handled with Rs. 1,764-3-1 out of the amount as under :—

11 Kutcha wells were dug.
13 wells were deepened by Kathawas, etc.
2 wells were cleansed.
1 well was repaired.
1 new Kandia well was constructed.

Many generous persons wrote to the Managing Committee offering sums of money for sinking of wells with troughs in the affected areas. Such grants were utilised for wells in places where the Committee was assured by the Government Officers that water ran scarce even during normal years. During this distress such grants would provide work for the poor ones of the District too. The Managing Committee gave such grants on the express condition that the Mahajan or other responsible body of persons applying for the grant should undertake in writing by an agreement with the local Government Officer to keep the well in good repair, and the trough, filled ever after. Grants have been given for construction of wells and troughs at following places at cost stated below :—

* Rs. 500 for a well and trough at Bhadwa (Hallar Prant, Kathiawar.)

„ 350 for a well and trough at Samadhiala Charan in the Songadh Thana (Gohilwad Prant). The cost of this has been given by Mr. Hargovinddas Moolchand of Bombay, in memory of Shethani Harkore, widow of the late Shet Damodardas Tapidas.

* The cost of this well was promised by "A Hindu Gentleman" but as the well could not be completed before the rains, the same has not been recovered.

Rs.	300	for deepening of wells at Chomalpur (Gohilwad Prant).
,,	1,202	for two wells and troughs at Virvadarka and Manaba through Malia Thandar. The cost of these has been defrayed out of Rs. 1,400 paid to this Committee by Mr. Mulji Damodar, of Bombay, in memory of his late wife and daughter.
,,	500	for repairs to a tank at Dudheri near Mahuva.
,,	200	for a well and trough at Songadh. The cost of this has been paid by Mrs. Surajbai in memory of her late husband, Mr. Chandulal Atmaran Kaji.
,,	150	for a trough at Sultanpur in Gondal State.
,,	300	for thorough repairs to a well and trough at Vadali, Mahi Kantha. The cost of this has been defrayed out of Rs. 1,400 paid to this Committee by Mr. Mulji Damodar, of Bombay, in memory of his late wife and daughter.
Rs.	3,502	

On the recommendation of Captain A. S. Meek, Political Agent, Gohilwad Prant, Rs. 300 were voted for deepening of wells at Chomalpur, as the Committee were assured that this deepening of wells would, besides leaving a permanent boon to the people concerned, enable them to raise irrigated crops for their cattle during earlier part of 1912.

14. *Bullocks Grants.*—Item (F) in the scheme of human relief of the Committee has been attended to by placing Rs. 12,194 at the disposal of the undermentioned officers and Committees for distribution of cheap or free bullocks to such cultivators as had neither cash nor credit to enable them to re-start their work.

4,000	Collector, Panch Mahals.
1,000	Political Agent, Mahi Kantha.
1,000	Political Agent, Palanpur.
2,000	Kathiawar Central Committee.*
1,194	Kalol Committee.
1,000	Collector, Ahmednagar.
1,000	Political Agent, Gohilwad.
1,000	Talukdari Settlement Officer, Gujarat, as a special grant to help those who had lost their cattle in the Gir and were in consequence helpless for their agricultural operations. This was voted in September 1912.
12,194	

These grants were made towards the end of June 1912, as the Managing Committee were informed that making these grants later would not be desirable, as the price of bullocks was going up. The Managing Committee could not vote more to this purpose at that time because they had to attend to

* Out of the Rs. 2,000 given for S. M. E. the K. C. F. R. C. returned Rs. 1,000 as not required.

appeals for relief from various parts of the affected areas, where rains were holding off. The distributing officers were requested to take necessary precautions that the bullocks thus made available to the poorest in the District may not be sold, thus frustrating the benevolent aim of this Fund. The Managing Committee are assured that necessary precautions have been taken and at some places the animals so given have been branded for the sake of being distinguished if trifled with.

15. The Managing Committee voted Rs. 25,000 to Mr. J. H. E. Tupper, I.C.S., Talukdari Settlement Officer, Gujarat, for the purpose of giving cattle free of cost price, to those who may have lost their cattle whilst out in Gir Forest for grazing purposes. The Managing Committee were aware that the experiment of transporting cattle to forests or jungles for grazing purposes was not a successful one in the last famine, but the arrangements made by Mr. Tupper in the Gir were reported to be thorough. However, the Managing Committee felt that a certain percentage of death-rate was natural. It struck the Committee that good half famished cattle which were available in March at rates ranging between Rs. 20 and Rs. 25 per head of cattle, would cost, after the rains, about Rs. 80 per head. It was therefore arranged that Mr. Tupper should buy cattle with these Rs. 25,000 and any further sum that he could get from other charitable persons and send them either to the Gir or keep them in the affected area in a camp, ultimately giving the same away to such ryots as may have lost their original cattle whilst in the jungles, charging them only the cost of upkeep during the intervening months. The following extract from Mr. Tupper's report shows how the scheme has worked out :—

"The net result of the operations was that 1,326 cattle (including cows, buffaloes, bullocks and a few bulls) were purchased with the funds subscribed, which amounted to Rs. 30,553. Of these cattle 1,181, estimated to be worth as nearly as possible Rs. 80,000 at current prices, were distributed in July to poor and deserving cultivators to replace animals lost in the Gir. The cost of purchase, averaging Rs. 23 per head, was lower than was anticipated, but the cost of maintenance, averaging Rs. 30 per head, was heavier. This was due to the cause already indicated and to the late inception of the monsoon, which rendered it necessary to keep the cattle for three weeks longer than had been expected before distribution. The total cost of operations, including purchase-money and maintenance, is in round numbers Rs. 70,000, leaving a net profit in round numbers of Rs. 10,000. The scheme has saved 1,181 cattle which otherwise would have had a very slender chance of survival. At a cost of some Rs. 30,000 to charitable subscribers, the operations have placed in thoroughly deserving hands Rs. 80,000 worth of cattle, for the upkeep of which since purchase the recipients will have to repay Government about Rs. 40,000 in easy instalments. The profit of Rs. 10,000 was made in about four months, so that if it be credited solely to the Rs. 30,000 subscribed, it represents 100 per cent. per annum calculated on the total expenditure of Rs. 70,000, the profit is nearly 43 per cent. per annum."

16. *Pinjrapoles and Gaushalas.*—Among the applications received for Cattle Relief grants many were from Managers of Pinjrapoles and Gaushalas in

the affected areas. As has been said above these had generally been provided for by private subscription lists. The Managing Committee, however, found that many needed hay at cost price and several needed help to take care of those cattle that had been admitted. Hay at cost price was given to all who applied and remitted money in advance. Morbi, Vankaner and Gondal Pinjrapoles imported lbs. 5,74,100, 1,61,365 and 1,00,975 respectively.

As to help by grants, the Managing Committee required more information about the system of working of such applicants. Pinjrapoles and Gaushalas as a rule, whilst admitting cattle, ask their owners to give up all right of ownership to them. Subsequently these cattle are, in some cases, never allowed to be used again for practical purposes; or, they are sold off, and proceeds utilized to swell the funds of the institutions concerned. In many Pinjrapoles bullocks once admitted are never put to work but continue to be fed at charity's expense.

These customs of Pinjrapoles and Gaushalas are far from deserving of encouragement, especially in a famine year. If it ever appeared to the Managing Committee that a certain Pinjrapole or Gaushala deserved help, the Managers were required to agree to one or more of the following conditions as the case may be :—

(1) Young and healthy cattle will, normal times prevailing, be handed over to their owners free of charge.

(2) Or if the owners be not traced these cattle be given away free to poor and deserving cultivators or respectable but poor private parties.

(3) All bullocks in the Institution will be employed and made available for agricultural operations.

The Mahajans of Tharad and Vao (Palanpur), Jodia (Jamnagar), Mundra, Anjar and Tera (Cutch) having agreed to these conditions, have received Rs. 5,500 from this Committee, Rs. 1,750 in cash and Rs. 2,500 in free hay.

Many Mahajans and private parties who had collected cattle for feeding purposes in what is known as "Vadas" refused to agree to the Managing Committee's conditions. On inquiring more closely the General Secretary learnt that some private individuals of means in the affected areas had opened Vadas in which they would receive the cattle of all such who chose to leave them there giving up their right of ownership. Such cattle owners would be persons of small means, but of some feeling; they would not sell their cattle to butchers for a few rupees, but would give them up to some respectable men who were likely to feed them during the critical months. What these men do is to beg charity money for upkeep of such cattle, and, at the end, sell the cattle (generally cows and buffaloes) at market rates when normal conditions prevail, pocketing the profit. On applications from such persons being received the Managing Committee asked the applicants to agree in writing to return the cattle to their owners free or at such prices as would cover their own out-of-pocket expenditure at upkeep. This was refused and no help was given from this Fund to such applicants.

17. *Co-operative Credit Societies.*—In 1912 the Committee wrote and offered Mr. R. B. Ewbank, I.C.S., Registrar, Co-operative Credit Societies, Bombay Presidency, a grant of Rs. 1,000 for cheap hay loss on sale of at Rs. 12-8 per 1,000 lbs. free on Rails at destination to deserving societies in the affected areas. The offer was gratefully accepted and indents were sent for hay despatches to officers of various Co-operative Credit Societies in Gujerat. The Managing Committee have fully completed all such indents received, having despatched in all lbs. 3,49,160 of hay to various Co-operative Credit Societies. In the case of two Co-operative Credit Societies, on the recommendation of Mr. Ewbank, Rs. 25 were given up as a special concession for loss in weight during transit.

18. *Help to Rabaries.*—Mr. Revashanker Jagjivandas offered to assist the Managing Committee in giving relief to the Rabaries of Chotila and surrounding districts whose cattle were said to be in great want. He required substantial assistance from the Managing Committee to begin his work and the Managing Committee voted a first grant of Rs. 5,000 for loss on cheap fodder to be sent to Botad and Ningala. Mr. Revashanker subsequently appealed to the charitable public direct and collected some money. The Committee gave him lbs. 10,49,300 of fodder at a total loss of Rs. 8,000 about, and the same is reported to have greatly helped the cattle of Rabaries in the said districts.

19. Although this Fund was started mainly for Gujerat, Kathiawar and Cutch, its central nature for the Bombay Presidency brought forth appeals for help from Collectors of Broach and Ahmednagar. In the Jambuser and Vagra Talookas of Broach, rainfall had been very scanty and great distress to the cattle and lower class of men was reported. Rs. 6,500 were voted to the Local Committee at Jambuser (out of which lbs. 1,02,625 costing Rs. 1,696-11-6 were sent) and Rs. 3,500 were voted and remitted to Mr. Otto Rothfield, I.C.S., Collector of Broach, for Vagra Talooka.

20. Mr. A. F. Maconochie, I.C.S., Collector of Ahmednagar, applied for help to the Ahmednagar Districts in June 1912. It was reported that although the cattle were worst off there, human distress also was very keen. Rs. 5,000 were remitted in cash and 2,25,618 lbs. of hay of the value of Rs. 3,700 about were despatched for free distribution.

21. It was reported that at stations on the Chitorgarh-Udepur Railway Line cattle distress was very severe. The Adhikari of the sacred Nath Dwar temple, near Mauli, imported lbs. 3,81,245 of hay at cost price from this Committee. To help the cattle of the people round about Mauli, the Condiment Merchants' Association offered to pay at full cost price for hay if it could be sent. Lbs. 3,55,865 of hay were despatched, and the Committee are informed the same proved a boon to the cattle there. Hay despatched to stations beyond Rutlam was not allowed the Government concession of one anna six pies per mile per wagon and the dearth of hay there has been brought to the notice of the Agent to the Governor-General, Rajputana, for favour of his sanctioning Government concession on this Committee's despatches to Mauli and to two more stations.

22. The affected areas comprised many Native States of all classes. Dewans of those First, Second and Third Class States that applied to the Committee direct were given grants after the Committee had assured themselves that the Durbars concerned were doing the needful by way of relief, which required to be supplemented by private charity. Some of the First Class States did not ask for grants so much as for supply of hay at cost price, and the Managing Committee paid prompt attention to their requirements. The Porbunder, Rajkot and Bhownagar States received from this Committee 4,097,515 lbs. in all at cost price. Those Native States that did not apply to this Committee officially have been given help through the local Mahajans on the latters' applications. States ranging below Third Class were required to apply to this Committee through their Political Agents.

23. In the report of the Bombay Presidency Famine Relief Committee of 1900 the following remark is made :—

"The Bombay Committee have not been able to assure themselves that "in the actual working of the Local Committees the non-official members have "taken as active a part as is desirable to ensure the most satisfactory distribu- "tion of the funds."

This Committee is pleased to be able to report that their grants were distributed to a great extent through Local Committees in which private individuals took an active part in distribution. In the whole of Cutch, at Bhavnagar, Sihore, Mahuva, Kundla, Amreli, Chital, Maliya, Botad, Viraumgam, Patri, Idar, Sadra, Surkhej, Bavla, Dholka, Mehmadabad, Nadiad, Burvalla, Cambay, Ambran, Bejana, Ghodasar, Ilol, Radhanpur, Kukadia, Rupal, Pethapur, Lunsar, Vadnagar, Sera, Badoli, Agas, money or hay was sent to private individuals or to Local Committees composed of private individuals. At most of the places local residents were required whenever possible to start their own fund, small though it may be, before asking for help from this Committee, and this, the Committee note with gratification, has greatly induced the local residents of the affected areas to take a sustained and efficient interest in superintending the operations of relief.

Attempts were made to form Committees of officials and non-officials as was done in the Panch Mahals by Mr. N. M. Joshi of the Servants of India Society, who assisted in the formation of the Taluka Committees at Halol, Kalol, Dohad and Godhra.

In Kaira, a few Local Committees of a similar nature were started, but this Managing Committee voted grants for the district direct to Mr. A. Chuckerbutty, I.C.S., Collector, Kaira, who distributed money and hay among the various Taluka Committees according to the needs of each. In all the following grants were voted :—

	Rs. 2,300	for human relief.	
About	„ 18,500	„ cattle	„
	„ 2,000	„ wells.	
	„ 1,275	„ free seeds.	

and lbs. 5,833,579 of hay distributed on behalf of this Fund.

Mr. H. L. Painter, I.C.S., Collector of Ahmedabad and Chairman of the Ahmedabad Famine Relief Committee asked for grants for the cattle-kitchens started by his committee. He was granted Rs. 22,500 in all of which he called for Rs. 4,000 in cash for special food to the cattle and the balance was worked off with lbs. 1,132,223 of free hay. The kitchens gave relief to about 4,500 heads of cattle and were successfully conducted.

For the Panch Mahals the Presidents of the various Local Committees communicated with the General Secretary and received help as under :—

(1) Halol Committee—

Rs. 1,500 for human relief,
„ 1,000 in cash for cattle relief, and
Lbs. 347,605 of free hay.

The number of cattle in the camp was 523 with no deaths.

(2) Kalol Committee—

Rs. 2,000 for human relief,
„ 1,000 in cash for cattle relief, and about
Lbs. 412,500 of free hay.

Rs. 1,194 proceeds of cheap hay were allowed to be reappropriated for bullocks ; number of cattle in the camp 500 with 7 deaths.

(3) Godhra Committee—

Rs.	9,000	for cattle relief.
„	1,000	„ clothing.
„	1,000	„ cheap grain.
„	1,000	„ filling water troughs.
„	7,000	„ gratuitous relief.

No hay was sent by this Committee as the Local Committee could buy hay cheaper.

(4) Dohad Committee—

Rs.	4,000	for cheap hay loss.
„	3,000	„ human relief.
„	610	cost of 200 blankets.

No hay was sent by this Committee as the Local Committee could buy hay cheaper.

Col. H. D. Merewether, Political Agent, Palanpur, worked with the assistance of Local Committees; but grants to the Palanpur Agency Thanas were given to the Political Agent for distribution at his discretion. Rs. 23,000 (Rs. 15,000 for cattle relief ; Rs. 5,000 for human relief ; Rs. 2,000 subsistance Tagavi ; Rs. 1,000 cheap bullocks) in all were voted including cost of lbs. 138,240 of hay despatched.

Major J. W. B. Merewether (and later on Major N. S. Coghill) Political Agent, Mahi Kantha, Major W. M. P. Wood, Political Agent, Jhalawad, Captain A. S. Meek, Politcal Agent, Gohilwad and Mr. C. G. Mehta, Deputy Assistant

Political Agent, Rewa Kantha, applied to this Committee in their official capacity and received grants as under :—

(1) Mahi Kantha—

Rs. 3,000 free fodder grant.
„ 16,500 cheap „
„ 1,000 „ bullocks grant.

Quantity of hay sent lbs. 2,237,909.

(2) Jhalawad Prant—

Rs. 1,800 for human relief.
„ 16,850 „ cattle „

Quantity of hay sent about lbs. 24 lakhs.

(3) Gohilwad Prant—

Rs. 756 for human relief.
„ 850 „ wells.
„ 5,500 cheap fodder grant.
„ 7,500 through Kathiawar Central Famine Relief Committee.
„ 1,000 for bullocks grant.
„ 500 „ fodder grant for Vala State.

Quantity of hay despatched lbs. 2,637,687 direct, lbs. 1,314,000 through Kathiawar Central Famine Relief Committee.

(4) Rewa Kantha—

Rs. 500 for human relief.
„ 2,000 „ cattle „

Quantity of hay sent about lbs. 175,000.

The Kathiawar Central Famine Relief Committee presided over by the Agent to the Governor rendered this Committee very useful help in distribution and in guiding this Committee regarding the qualifications of those who applied to the Committee for help. Grants to the Managed Estates in Kathiawar* and to the Halar Prant were given through the Kathiawar Central Committee. Total grants made Rs. 22,000 about for cheap fodder loss ; Rs. 500 for a well ; Rs. 100 for Brahmin Relief ; quantity of hay sent lbs. 4,425,000.

24. The Government officials at all stations in the affected areas co-operated with the Managing Committee most cordially in distribution of grants, &c., and the Managing Committee desire to thank them all very heartily.

Mr. S. N. Pandit, Vice President, Kathiawar Central Famine Relief Committee, was unremitting in his efforts to see that the Committee's help reached all deserving cattle and men in the whole of Kathiawar. He corresponded very fully and lucidly with the General Secretary on behalf of the Kathiawar Central Famine Relief Committee and the Managing Committee beg to thank him very heartily for his valuable co-operation.

The Managing Committee desire to record with special appreciation the help rendered to them in distribution by the following amongst other energetic gentlemen :—

(1) Mr. Panachand Mojilal of Matar Dist., Kaira.
(2) „ Khattau Valjee of Cutch, (Manjal).

* Mr. Hormasji J. Antia, Superintendent, Managed Estates, applied to this Committee direct in June 1912 and was voted Rs. 1,250 as cheap fodder grants and given lbs. 325,450 of hay.

(3) Mr. Ranchoddas Tricumjee Jivandas of Anjar.

(4) Messrs. Sakarchand Panachand and Jivram Ajramar of Bhuj.

(5) Mr. Maganlal Jayachand, President, and Mr. Howbhai Vrujlal, Honorary Secretary of the Viramgam Cattle Kitchen.

(6) Mr. Chaturbhuj Manakeshwar of Sadra.

Messrs. Mangaldas M. Munshi and Manjee Mowjee of Bombay took great pains to be useful to the affected areas by visiting various parts from time to time to ascertain the needs and to assure themselves that distribution of fodder from this Committee was being carried on in a satisfactory manner.

The zeal of the Government officials in the affected areas for collection of charity money and proper distribution of relief during this period was general, but the efforts made by Major Wood, the Political Agent, Jhalavad Prant, and Captain Meek, Political Agent, Gohilwad Prant, through his Deputy Mr. H. N. Gosalia for collection in Bombay for adequate relief in their Prants deserves to be specially noted. Major Wood commenced his collection in November 1911 when on a short visit to Bombay. Mr. Gosalia started his collection in May 1912, which was considered by many to be a very late start for a successful collection. But within about three weeks Mr. Gosalia succeeded in collecting about Rs. 20,000 which sum under the orders of Captain Meek he deposited with this Managing Committee for hay despatches to Gohilwad Prant; he was thus instrumental in affording substantial relief to the cattle in his Prant, at the same time relieving this Committee from the necessity of making further grants for Gohilwad, which, but for his collection, would have been quite imperative.

25. Besides local Committees and officials in the affected areas the Salvation Army offered to the Committee their services for distribution of help in Kaira and Ahmedabad Districts. This was readily accepted, and, as mentioned above, the Cheap Grain Shops were worked through them at a total loss of Rs. 1,500, the grain having been sold at half cost price. The Salvation Army also agreed to send up their representatives to inland villages of Jamnagar for distribution of grain there amongst persons who were reported to be in great distress. Rs. 1,000 were spent through them and the accounts rendered were satisfactory. They also distributed for this Committee 60,000 lbs. of cheap hay at Rs. 12-8-0 per 1,000 lbs. at Cambay in June, and towards the middle of the same month when distress to the cattle of Rabaries in the Kaira District was reported to be most keen, a Cattle Kitchen was opened by them for this Committee at Barejadi where 750 heads of cattle were fed during the most critical period before the monsoon set in. The Managing Committee desire to record their best thanks to Col. Blowers of the Salvation Army for his willing and efficient assistance.

26. The Servants of India Society had a number of their representatives moving about the affected areas and their assistance was requisitioned from time to time whenever available, such as Mr. Subaiya in Kathiawar, Messrs. Joshi and Ramchandrarao in Panch Mahals and Mr. Tivary at hay-despatching

stations in U. P. Mr. S. G. Gogate who was at Bamnia in charge of the hay despatching operations, and later on Mr. S. V. Lalit, who was at Ahmedabad, were at the disposal of this Committee and they both rendered very useful services.

The Servants of India Society have besides procured for this Fund Rs. 16,000 as contributions principally from parts of India outside the Bombay Presidency. The sums subscribed range from a few annas up to Rs. 5,000, being Mr. Lala Lajpatrai's first donation out of the balance in his hands of the Punjab Famine Relief Fund of 1908. The best thanks of the Managing Committee are due to Messrs. G. K. Devdhar and Krishna Prasad Kaul for this handsome collection.

27. The best thanks of the Managing Committee are also due to Mr. Ichharam Suryaram Desai, Editor and Proprietor of the Gujerati, and the members of the Social Service League, Bombay, who procured for this Fund Rs. 19,282-3-0 and Rs. 19,025, respectively. The former started a " One Anna Fund " in the columns of " the Gujerati, " and the latter very kindly organised a house-to-house visitation in Bombay in February 1912 in aid of this Fund. Total proceeds of both funds have been handed over to this Committee, for distribution.

28. In Bombay Mr. Rupshanker U. Oza commenced giving very good assistance to the General Secretary since March 1912. Towards the end of June 1912 he went to Viramgaum at his own expense to try and form there a local Committee to start a Cattle-Kitchen for cattle of Rabaries which were said to be in pressing need of help then. The arrangements made by Mr. Oza for the supervision of the Cattle-Kitchen have worked most satisfactorily, and fully 680 heads of cattle received relief at the Kitchen for nearly six weeks.

29. The Managing Committee beg to record best thanks to the Under Secretary to the Government of Bombay, Revenue Department, for regularly supplying to this Committee the Famine Reports from time to time.

30. Although the actual contributions to this Fund amount to Rs. 3,46,000 about the turnover on account of this Fund exceeds Rupees seven lakhs, and the satisfactory and efficient manner in which Mr. Nagindas Damoderdas has kept the accounts of this Fund deserves mention. He has refused to be paid for his labour. The Managing Committee desire to record their appreciation of his efficient handling of this Fund's cash and accounts.

31. The Managing Committee beg to thank the Council of Management of the Bombay Presidency Association for allowing free use of their spacious rooms for meetings in connection with this Fund.

32. Of the total contributions, the Managing Committee had voted out Rs. 3,45,000 as grants, holding the balance against charges of establishment of the Fund. After the setting in of rains in the affected areas, when fresh fodder was practically assured, many of the officers and individuals who had received help from this Committee returned their unspent balances

which go to make up the actual closing balance of Rs. 19,700 about, out of this closing balance a first remittance of Rs. 14,000 has been made to the Indian People's Famine Fund Trust, Calcutta, and after defraying the charges of printing of the report, etc., the balance in full will be returned to the Indian People's Famine Fund Trust as a final remittance of the unspent balance of this Fund.

33. The total amount of money spent on Cattle Relief, Human Relief and for Wells is Rs. 2,53,000, 71,000 and 5,300 approximately, respectively. Of the total quantity of fodder moved, *viz.*, lbs. 358,000,000, lbs. 23,600,000 have been given as cheap hay, lbs. 8,600,000 have been given at cost price and lbs. 2,750,000 as free hay. It will be seen that the major part of this Committee's help has gone to supplement the self help of cultivators and private owners of cattle by making available to them the hay at a rate which they could afford, the Committee bearing the difference between the market price and the selling rate out of this Fund.

The following are the names of places stating the number of cattle fed at each kitchen or camp :—

Godhra	500
Halol (Vada Talao)	523
Kalol (Vejalpur and Derol)	500
Viramgaum	706
Barejadi	750
Sarkhej	1,300
Vadnagar*	1,175
Maliya	300
Patri	320
Sokra	870
Chital	100

At Godhra, Halol and Kalol, Cattle Camps on behalf of this Committee were organised and conducted by the Local Committees. At Sokra, Major Wood was responsible for the Cattle-Kitchen on behalf of this Committee. With these exceptions the initiative for the other Cattle-Kitchens mentioned was taken by this Committee the management being entrusted to the local persons at each place; but these latter were opened in and after June 1912, when it was recognised that Rabaries and poor cultivators were completely unable to buy even cheap fodder.

Lbs. 10 of hay was given per head of cattle as a rule and they kept fairly well on it. The death-rate at the several camps and kitchens has been practially negligible working out at less than half per cent. At some Cattle-Kitchens cotton-seed husks were given in part substitution of hay, and, in several cases owners of cattle, when assured of the preservation of their cattle, treated them to cotton-seeds once a week at their own expense to prevent them from getting very weak.

* Started by Mrs. Jamanabai Sakai, during her tour in the affected areas.

34. As said at the commencement in this Committee's appeal, the distress during this famine was keenest for the cattle. Although no full statistics of the death rate of cattle are available, the final reports of the several Government Officials show that the mortality amongst cattle in the affected areas has not been anything near to what at one time was feared. In fact from many badly affected parts in the famine districts, the Committee are assured that the plough cattle have been fully saved and even the milch cattle have not decreased much in numbers.

BOMBAY, 15*th October* 1912.

PHEROZESHAH M. MEHTA,
President.

C. H. ARMSTRONG,
Chairman of the Final Meeting of the Managing Committee.

PURSHOTAMDAS THAKURDAS,
Honorary General Secretary and Treasurer.

Statement showing the accounts of the Bombay Central Famine Relief Fund as on 31st October 1912.

CREDIT.

	Rs.	a.	p.
Contributions received from the Indian People's Famine Fund Trust, Calcutta	1,50,000	0	0
Donations received from the public.			
General Relief	1,69,249	12	9
Human Relief	5,412	8	0
Cattle Relief	19,805	4	9
Wells	1,950	0	0
	1,96,417	9	6
Amount remitted by Kathiawad Central Famine Relief Committee as a special refund	1,500	0	0
Suspense account owing by this Fund	1,340	5	6
Total ...	3,49,257	15	0

NAGINDAS DAMODARDAS,
Honorary Cashier.

BOMBAY, 31*st October* 1912.

DEBIT.

	Rs.	a.	p.
Grants paid for Human Relief	71,394	4	7
Grants paid for Cattle Relief	2,51,182	7	8
Grants paid for Wells	5,502	0	0
Total Rs....	3,28,078	12	3
Expenses of management and sundries ... ... Rs.	2,734	14	7
Suspense account owing to this Fund ... ... ,,	422	7	10
Refunded to Indian People's Famine Fund Trust, Calcutta ... ... ,,	14,000	0	0
Cash balance—			
Balance at Bombay Bank ... Rs. 3,907 6 2			
Balance on hand ... ... ,, 114 6 2			
,,	4,021	12	4
Total Rs. ...	3,49,257	15	0

PURSHOTAMDAS THAKURDAS,
Honorary General Secretary and Treasurer,
Bombay Central Famine Relief Fund.

NOTE.—(1) The amount spent on cattle relief includes Rs. 1,990-4-9, loss on sale of balance of hay sold off in August 1912, after good rains had fallen in the affected areas. The quantity in balance was held on account of some of the officers and Committees in the affected areas who applied for hay, but wired requesting that despatch of same may be stopped owing to fresh fodder being available locally. As this Managing Committee had a cash balance in hand they did not press for recovery of the loss from the indenting persons in view of the fact that their not taking up the hay was due to causes beyond their control.

(2) The final accounts of the Fund cannot be made up until the cost of printing and distributing the reports is ascertained, and the suspense accounts cleared. On this being finished a Memo. showing the final accounts will be issued and full balance in hand remitted to the Indian People's Famine Fund Trust, Calcutta, as per resolution of the Managing Committee.

The following is a list of grants voted from time to time by the Bombay Central Famine Relief Fund Committee :—

Punch Mahals—

Rs.	19,000	0	0	Godhra Local Famine Relief Committee (for Cattle and Human Relief).
,,	9,750	0	0	Kalol Local Famine Relief Committee.
,,	8,000	0	0	Holol ,, ,, ,, ,,
,,	8,610	0	0	Dohad ,, ,, ,, ,,
,,	500	0	0	Zalod ,, ,, ,, ,,
,,	750	0	0	Rev. J. MacNeil (for Human Relief).
,,	350	0	0	Mr. M. H. Kothawalla of Godhra (for his Cattle Kitchen).
,,	2,441	8	0	Mrs. Jamanabai N. Sakkai for distribution during her tour.
,,	4,000	0	0	Collector, Punch Mahals (for cheap and free bullocks to the cultivators).
Rs.	53,401	8	0	

Kaira—

Rs.	22,800	0	0	Mr. A. Chuckerbutty, I.C.S. (Collector, Kaira).
,,	1,765	2	8	Col. A. R. Blowers of the Salvation Army (for Barejadi Cattle Kitchen).
,,	5,402	5	6	Mr. Panachand Mojilal of Matar (for Cattle and Human relief).
,,	500	0	0	Nadiad Local Committee (Mr. D. K. Pandya).
,,	200	0	0	The Secretary, Nadiad Hindu Orphanage.
,,	100	0	0	The Hindu Nirashrit Fund, Nadiad.
,,	7,626	6	6	Cheap hay loss (through Mr. Monjee Mowji).
Rs.	38,393	14	8	

Ahmedabad and North Guzerat including Mahikantha and Rewakantha and Palanpur Agencies—

Rs.	26,000	0	0	Mr. J. H. E. Tupper, I.C.S. (Talukdari Settlement Officer, Gujerat).
,,	23,000	0	0	Palanpur Agency (through the Political Agent, Palanpur).
,,	22,500	0	0	Mr. H. L. Painter, I.C.S. (Collector, Ahmedabad).
,,	19,500	0	0	Mahikantha Agency (through the Political Agent, Mahikantha).
,,	2,500	0	0	For Tharad and Wao Mahajans (through the Political Agent, Palanpur).
,,	2,500	0	0	Rewakantha Agency (through the Deputy Assistant Political Agent).
,,	2,000	0	0	Sarkhej Cattle Kitchen (through Mr. Chaganlal Keshavlal Trivedi).
,,	2,000	0	0	Dholka Famine Relief Committee (through Mr. Manilal, Chairman, Famine Relief Committee).
,,	2,000	0	0	Balasinor State (through the Administrator, Balasinor).
,,	2,000	0	0	For general relief, Cambay (through Mr. Deepchand Panachand).
,,	2,000	0	0	Palanpur State (through the Chief Karbhari, Palanpur).
,,	2,728	14	11	Viramgaum Cattle Kitchen (through Mr. Howbhai Vrujlal).
,,	1,471	10	6	For a Cattle Kitchen at Vadnagar (through Mr. Vallabhram Kalidas).
,,	4,101	6	0	For a Cattle Kitchen at Vadnagar (through Mr. Bhogilal Chakulal).
,,	3,038	2	6	For cheap and free hay at Idar and surrounding villages (through Mr. Lallubhai Karunashanker).

Ahmedabad and North Guzerat—contd.

Rs.	1,500	0	0	For cheap grain distribution in Kaira and Ahmedabad Districts (through Col. A. R. Blowers).
,,	1,000	0	0	Sarkhej Gavrakshak Committee (through Mr. Chaganlal Keshavlal Trivedi).
,,	1,000	0	0	Bhal (through Mr. Mangaldas M. Munashi).
,,	1,000	0	0	Ahmedabad Orphanage.
,,	1,000	0	0	Mr. R. B. Ewbank, I.C.S., Registrar, Co-operative Credit Societies.
,,	1,000	0	0	Radhanpur (through the Radhanpur Jain Mandal, Bombay).
,,	695	7	0	For cattle and human relief at Ghodasar (through Mr. Damodar Laxmiram Pandya and others).
,,	360	0	0	Loss on cheap hay at Cambay (through Col. A. R. Blowers).
,,	350	0	0	For cattle relief (through the Thakore Shree of Varsoda).
,,	350	0	0	Swami Adbhutanand of Achalgarh.
Rs.	~~1,14,255~~ 1255-95-8-11	~~7~~	~~0~~	

Total for Panch Mahals, Kaira, Ahmedabad Districts, Palanpur, Mahikantha and Rewakantha Agencies and North Guzerat—Rs. ~~2,06,050-13-8.~~ 214390-15-7

Kathiawar—

Political Agents and Superintendent, Managed Estates,—

Rs.	25,561	0	0	The Kathiawar Central Famine Relief Committee.
,,	18,650	0	0	Major W. M. P. Wood (Zallavad Prant).
,,	7,256	0	0	Captain A. S. Meek (Gohilwad Prant).
,,	2,282	2	0	Maliya Mahajan (through Thandar, Maliya).
,,	1,250	0	0	Superintendent, Managed Estates (Rajkot).
,,	1,000	0	0	Wadhavan Ladies' Camp (through Major W. M. P. Wood).
,,	150	0	0	Chuda Mahajan (through Manager, Chuda).

Native States—

Rs.	2,000	0	0	The Chief Karbhari, Limdi.
,,	1,000	0	0	Kundala Committee.
,,	1,000	0	0	Mahajan, Patri (through Mr. Ramchandra Govind).
,,	1,000	0	0	Mahajan, Amreli (through Mr. Jamnadas Goculdas).
,,	250	0	0	Sayala Cattle Camp.
,,	1,500	0	0	Mahajan, Mahuva (through Messrs. Vachraj Trimbak and Manjee Nathabhai and others).
,,	250	0	0	Mahajan, Sihor (through Mr. Chaturbhuj Bhaichandbhai).
,,	200	0	0	Mahajan, Unav.
,,	100	0	0	Mahajan, Lathi (through Mr. Naranjee Rajpal).
,,	50	0	0	Sawar.
,,	500	0	0	The Karbhari, Vala State.
,,	500	0	0	For cattle relief to Dhorajee Mahajan (through Mr. Manjee Jivraj).
,,	1,000	0	0	Col. Blowers (for human relief, Jamnagar).
,,	200	0	0	For human relief to Mahajan, Jetpur (through Major Carter, Political Agent, Sorath Prant).
,,	50	0	0	For human relief at Lunsar (per Mr. Muljee Prabhashanker).

Native States—contd

Rs.	500	0	0	For human relief (through Bhownagar Famine Relief Committee through Mr. Kuverjee Anandjee).
„	1,000	0	0	For human relief at Siohr (through Mr. Chaterbhuj Bhaichandbhai).
„	1,500	0	0	The Dabasang Fund, Jamnagar, for human relief (through Mr. Hirjee Khetsey).
„	180	0	0	For human relief at Mota Charodia (through Shastri Jagjivan Kalidas) and a parcel of clothing.
„	1,000	0	0	Mahajan Jodia (through Mr. Khimji Dayal).
„	200	0	0	For Human Relief at Bagasara (through Mr. Ichashanker Durgashanker).
„	229	15	10	For Human Relief at Jam-Jodhpur (through Mr. Vallabhdas Kuverjee).
„	881	2	6	Chital (through Kumar Shri Ranigwalla).
„	7,848	1	9	For cheap hay at Botad and Ningala (through Mr. Rewashanker Jagjivan).
Rs.	79,088	6	1	

Deccan—

Rs.	250	0	0	Sankheswar Gaurakshak Sabha, Jamkhandi (through Mr. Chaturbhuj Morarji).

Cutch—

Rs.	1,500	0	0	Mundra Panjrapole for Cattle Relief.
„	1,000	0	0	Anjar Panjrapole for Cattle Relief (through Mr. Tricumjee Jivandas).
„	25	0	0	Palasva Panjrapole for Cattle Relief (through Mr. Kothari Sunderji Karamsey).
„	250	0	0	Durgapur Panjrapole for Cattle Relief (through Mr. Ghelabhai Ganasey).
„	250	0	0	Tera Panjrapole for Cattle Relief (through Mr. Karamsey Keshavji).
„	2,750	0	0	Mandvi Mahajan for Cattle Relief (through Mr. Kanji Dwarkadas).
„	4,150	0	0	Mr. Sakarchand Panachand (for Human Relief).
„	3,300	0	0	Mr. Khatau Valajee (for Human Relief).
„	250	0	0	Kothara Panjarapole (through Mr. Laljee Vasanji).
„	7,500	0	0	Mr. Tricumji Jivandas (for Human Relief).
„	300	0	0	Tuna (through Mr. Motichand Ranchordas).
„	1,250	0	0	Nalia Mahajan (through Messrs. Vallabhdas Hirji and Mathuradas Ravji).
„	500	0	0	Lakpat (through Mr. Mulji Pradhan).
Rs.	23,025	0	0	

Broach—

Rs.	6,500	0	0	Jambusar Famine Relief Committee (through Collector of Broach).
„	3,500	0	0	Collector of Broach (for Wagra Taluka).
Rs.	10,000	0	0	

Ahmednagar—

Rs.	9,000	0	0	Through the Collector.
„	5,502	0	0	Wells grant (as per para. 13 in the report).
„	1,000	0	6	For sundry small applications.
Rs.	~~3,44,455~~	~~4~~	~~8~~	Grand Total.

34525-5-8

APPENDIX **A.**

Statement showing rainfall in some of the districts of the affected areas in 1911 *and the average of previous five years.*

Name of District.	Rainfall in 1911. (1st June 1911 to 31st October 1911).	Average of previous five years.
Cutch—		
Bhuj	1·68	13·19
Kathiawar—		
Dwarka	2·65	13·67
Rajkot	2·11	27·40
Porbunder	4·72	18·95
Babra	3·58	21·14
Wadhwan	6·42	18·89
Muli	2·46	22·58
Patri	2·64	19·55
Mahi Kantha—		
Sadra	6·90	23·95
Katosan	3·42	33·51
Idar	14·80	46·73
Rewa Kantha—		
Dedka	9·69	26·77
Pandu	12·81	37·91
Kaira—		
Kapadvanj	8·73	32·45
Thasra	8·57	34·18
Kaira	11·16	33·26
Anand	11·59	36·64
Punch Mahals—		
Godhra	6·66	44·57
Kalol	11·17	41·30
Halol	10·52	43·24
Dohad	10·26	28·5
Ahmedabad	9·84	32·55
Palanpur—		
Deesa	9·76	23·36
Deodar	1·25	16·27

APPENDIX B.

Office Bearers of the Bombay Central Famine Relief Fund.

President.

(1) The Hon'ble Sir P. M. Mehta, K.C.I.E.

Vice-Presidents.

(2) The Hon'ble Mr. C. H. Armstrong.
(3) Sir Dinshaw M. Petit, Bart.
(4) Sir Jamsetjee Jeejeebhoy, Bart.
(5) Sir Currimbhoy Ibrahim, Bart.
(6) Sir Cavasji Jahangir, Bart.
(7) Sir Bhalchandra Krishna Bhatwadekar, Kt.
(8) The Hon'ble Sir Vithaldas D. Thackersey, Kt.
(9) Sir Adamji Peerbhoy, Kt.
(10) Mr. H. A. Wadia.

Chairman of the Managing Committee.

Mr. H. A. Wadia.

Honorary Secretaries.

(1) The Hon'ble Mr. G. K. Parekh.
(2) (The Late) Mr. Dharamsey Morarji Gokuldas.
(3) Mr. N. S. Glazebrook.
(4) Hon'ble Mr. Fazulbhoy Currimbhoy Ibrahim.
(5) The Hon'ble Mr. Abdulhusain Adamjee Peerbhoy.
(6) Mr. Jehangir B. Petit.
(7) Mr. Khetsey Khaisey.
(8) Mr. Ramnarain Haranandrai.
(9) Sir Jagmohandas Varjivandas, Kt.
(10) Mr. Rawjibhai Narayanji.
(11) Gopal Krishna Devdhar, M.A.

Honorary General Secretary and Treasurer.

Mr. Purshotumdas Thakurdas.

Honorary Assistant Secretaries.

(1) Mr. Ratansey Dharamsey.
(2) Mr. B. N. Motiwalla.
(3) Mr. N. M. Joshi.

Members of the Managing Committee.

(1) The Hon'ble Sir Henry Procter, Kt.
(2) Mr. Narottum Morarji Gokuldas.
(3) The Hon'ble Mr. Lallubhai Samaldas.
(4) The Hon'ble Mr. Manmohandas Ramji.
(5) The Hon'ble Mr. H. R. Greaves.
(6) Sir Shapurji Broacha, Kt.
(7)
(8) Mr. F. R. Wadia.
(9) Mr. Tribhovandas Vurjivandas.
(10) Rao Bahadur Vussanji Khimji.
(11) Mr. Lukhamsey Nappoo.
(12) Mr. Damoderdas Gordhandas Shukhadwalla.
(13) Rao Saheb Sir Vussunji Tricumji Moolji, Kt.
(14) Mr. Rutansey Moolji.
(15) Mr. Purshotam Vishram Mavji.
(16) Mr. Tribhovandas N. Malvi.
(17) Hon'ble Mr. Justice G. S. Rao.
(18) Mr. Manekchand Panachand Javeri.
(19) Mr. Revashanker Jagjivan.
(20) Mr. M. R. Vajifdar.

Members of the Managing Committee—contd.

(21) The Hon'ble Sir Ebrahim Rahimtoola, Kt., C.I.E.
(22) Mr. P. C. Shethna.
(23) Mr. Motilal Kanji.
(24) Mr. Hirachand Manekchand.
(25) Mr. Motilal Vallabhji.
(26) Mr. K. Natrajan.
(27) Mr. R. N. Vatchagandhy.
(28) Mr. D. G. Padhye.
(29) Mr. Ichharam Suryaram Desai.
(30) Rao Bahadur Keshavji Nathu Sailor.
(31) Mr. D. G. Dalvi.
(32) Dr. Kaliandas J. Desai.
(33) The Hon'ble Mr. D. L. Graham.
(34) Rao Bahadur Sunderdas Narandas.
(35) Rao Bahadur Karamsey Damji.
(36) Mr. Pragji Soorji.
(37) Mr. Hunsraj Pragji.
(38) Mr. Kursandas Moolji Jetha.
(39) Mr. Churandas Chatterbhuj.
(40) Mr. Bhulabhai J. Desai.
(41) Mr. Lallubhai A. Shah.
(42) Mr. K. R. Mitra.
(43) Mr. Y. A. Kunte.
(44) Mr. Chatturbhuj Shivji.
(45) Mr. Mahmadbhai Hajibhai Lalji.
(46) Mr. Fazalbhoy Meherally Chinoy.
(47) Mr. Cassumally Jerajbhoy Peerbhoy.
(48) Mr. Gordhandas Khatau.
(49) Mr. D. E. Wacha.
(50) Mr. Manilal Kesrisingh.
(51) Mr. Lalshanker Hariprasad.
(52) Mr. K. J. B. Wadia.
(53) Mr. Chhotalal Kilachand.
(54) Mr. Jivanlal Panalal.
(55) Mr. Girdhardas Jethabhai.
(56) Mr. Narayandas Purshotumdas.
(57) Mr. Purbhudas Jivandas.
(58) Mr. Bhogilal Veerchand Deepchand.
(59) Mr. Dalsukhbhai Vadilal Veerchand.
(60) Mr. K. M. Javeri.
(61) Mr. Fazalbhoy Jumabhai Laljee.
(62) Mr. Sarabhai Maganbhai Mody.
(63) Mr. H. C. Koyajee.
(64) Mr. Manilal Mohandas.
(65) Mr. Ishwardas Laxmidas.
(66) Mr. Puranmall Guljee Singhani.
(67) Mr. R. U. Oza.

APPENDIX C.

FAMINE RELIEF.

Big Bombay Meeting.

AN APPEAL FOR PHILANTHROPY.

Very successful was the meeting which was held on Tuesday afternoon in the Bombay Town Hall, called by the Sheriff at the requisition of leading citizens for the purpose of shedding light on the need which exists for the continuation of financial support to the Bombay Central Famine Relief Fund. There was a large gathering, presided over by His Excellency the Governor, and after hearing speeches which showed the growing necessity for helping forward the objects of the fund, during the next four months resolutions were unanimously passed pledging that support, the receipt of several handsome donations being announced.

Among those on the platform were:—The Bishop of Bombay, the Hon. Mr. M. B. Chaubal, the Hon. Sir Pherozeshah M. Mehta, Sir Cowasji Jehangir, the Hon. Mr. C. H. Armstrong, the Hon. Mr. W. L. Graham, the Hon. Mr. H. R. Greaves, Sir Bhalchandra Krishna, Mr. Narotum Morarji Goculdas, the Hon. Fazulbhoy Currimbhoy Ebrahim, the Hon. Mr. Lalubhai Samaldas, the Hon. Mr. Manmohandas Ramji, Mr. Jagmohandas Varjiwandas, Mr. Dharamsey Morarji Goculdas, Mr. D. E. Wacha, Mr. N. S. Glazebrook, Mr. T. W. Birkett, Mr. H. A. Wadya, Col. Blowers, Mrs. Jamnabai Sakai, Mrs. Laxmibai Ranade, Mr. G. K. Deodhar and others.

Letters were received among others from Mr. Dadabhoy Nowroji, the Rev. D. Mackichan, the Hon. Sir H. E. E. Procter, the Hon. Sir Vithaldas D. Thackersey, and Mr. Vijbhukhandas Atmaram, expressing their sympathy with the object of the meeting.

Sir Pherozeshah Mehta, proposing the election of His Excellency Sir George Clarke to the chair, said he did not ask the Governor to take the chair, as Governor of Bombay, for the reason that in his official capacity he had already done everything in his power so far as measures for the alleviation of the distress and suffering which had arisen in this Presidency were concerned. They asked Sir George Clarke to preside as the head of the society in the Presidency, and they might be sure that the same earnestness and the same cordiality would be displayed by His Excellency in discharging his duty as the head of the meeting as he had already done in the discharge of the many functions he had to discharge as the Governor of Bombay.

The Hon. Mr. W. L. Graham briefly seconded the resolution, which was heartily carried.

The Governor, on taking the chair, mentioned that he had received a letter from an anonymous writer who sent a donation of Rs. 10 and said: "God have mercy on the poor men and cattle—Sympathiser." These, said His Excellency, were words which all could echo.

The receipt of the following donations was also announced:—Mr. Ratan J. Tata, Rs. 5,000; Miss Tata, Rs. 5,000, proceeds of a draft of £300, from Indian Pearl Merchants of Paris, Rs. 4,456-7-8; Sir Dorabji J. Tata, Kt., Rs. 1,500; Messrs. W. and A. Graham and Co., Rs. 1,000; Messrs. David Sassoon and Co., Ltd., Rs. 1,000; Mrs. Jamanabai N. Sakkai's collection (third instalment), Rs. 500; and the Hon'ble Mr. Lallubhai Samaldas Rs. 500.

H. E. THE GOVERNOR.

His Excellency the Governor, who was enthusiastically received, then said :—Ladies and gentlemen,—We have come together in this public meeting for the best of all causes—that of endeavouring to alleviate distress and loss among our fellowmen and women in the drought-stricken portions of the Presidency. Perhaps it may be useful if I attempt to give you a general idea of the scope and conditions of the prevailing scarcity followed by a statement of what has been and is being done by the various agencies which are ministering to the needs of the people. We shall thus be placed in a position to understand what further assistance is required and how best to apply it.

The rainfall of 1911 was seriously deficient throughout the Presidency, but especially in the five districts of Gujarat, the adjoining Native States and Kathiawar, which received considerably less than half of the normal amount. As a result, crops almost completely failed in the Panch Mahals and in most parts of the Ahmedabad and Kaira districts while the north of the Broach district suffered from a failure of the late rains. In the Deccan most fortunately there were good late rains in October and November which saved the situation except in Ahmednagar district and in parts of West Khandesh, Poona and Sholapur where the crops have yielded less than a four-anna return. In East Khandesh, Nasik and Satara, the season has been bad, but relief measures will probably not be necessary. The Southern Mahratta country has also suffered, but distress exists only in a few tracts Most fortunately the two preceding seasons were good by which the resources of the cultivators were greatly helped. This happy circumstances, combined with the good late rains which fell locally, has saved us from a situation which might have been critical. Moreover, in the Deccan and Southern Mahratta Country and also in Kathiawar, the characteristics of the agricultural classes have been changed by the sad experiences of the great famine of 1899-1900. The frequency of crop-failure has taught the people the value of their labour and they have become accustomed to travel long distances to obtain employment. Most fortunately there has been a large demand for labour during this season, in the cotton tracts of Khandesh and Berar, in the irrigated areas of the Deccan, and in the many great public and private works which are now in progress. This new fluidity of labour is an important factor in famine times, and except possibly in the Bijapur District, we may hope that no regular relief works under the famine code will be required in the Deccan and Southern Maratha Country.

A FODDER FAMINE.

For the most part, as the figures I shall give later, will show it is a fodder famine with which we have to deal. The only District in which human suffering threatened to become acute is the Panch Mahals, where alone famine has been declared. Special difficulties arise in dealing with this District where the population is largely composed of aboriginal or unsettled tribes, who have no resources to fall back upon, who are unaccustomed to any regular work, and who will not readily camp at a distance from their villages. Test works have been opened in the Kaira District; but they have attracted few workers and it seems unlikely that famine will have to be declared in this District. In the Viramgam, Dholka and Dhandhuka talukas of the Ahmedabad District it may be necessary to start regular relief works and Government are prepared to utilize the projected Viramgam-Sami Railway for the purpose. Test works have been opened in Bijapur District, but the attendance is extremely small.

In Kathiawar, the cultivators had enjoyed two exceptionally prosperous seasons with high prices for their produce ; but the terrible lesson of 1899 had not been forgotton, and when the possibility of a failure of the rains presented itself even as early as July, the people showed promptitude in developing well cultivation and in constructing as many as 6,780 new wells which have been the means of saving nearly 30,000 head of cattle. Famine has been already declared in a few Native States, where about 3,000 persons are employed on regular relief

works, while test works with about 5,000 workers have been started in Kathiawar and in Palanpur and Rewa Kantha. Human distress has not as yet been severely felt and less than 3,000 persons are receiving gratuitous relief in Native States, but the lack of fodder is acute, and Kathiawar will certainly need more assistance as the time passes

Suspension of land Revenue.

I will now explain briefly what Government have done up to the present time. In the first place the suspensions of land revenue will amount to about 75 lakhs and the remissions to 17 lakhs, of which 30 and 3 lakhs, respectively, will go to Gujarat. In the Deccan the corresponding figures will amount to 12 and 3 lakhs respectively for the Ahmednagar District alone. Besides the ordinary tagai grants of Rs. 24½ lakhs included in the current year's budget, an additional allotment of Rs. 28 lakhs has been sanctioned for the affected districts of the Presidency. Loans to Jurisdictional States for famine purposes will amount to Rs. 48 lakhs and to non-Jurisdictional States to Rs. 9½ lakhs. The total number of persons employed on Government works was 51,387 on the 9th instant, of which number 40,752 in Panch Mahals are employed on regular relief works. At the same date, the total number of persons on Government gratuitous relief was 46,225 including 3,323 dependants and village servants. The great bulk of this form of relief is being given in Panch Mahals; but Kathiawar, Palanpur and Rewa Kantha are included while in Poona and Sholapur village servants are being assisted. The Government provision of fodder has been on an immense scale extending to 1,100 lakhs of lbs., of which 750 lakhs have been obtained from the forests of Thana, Surat, West Khandesh and Kolaba and the remainder from the Central Provinces. This vast mass of fodder is mainly for distribution as tagai to be recovered by easy instalments in succeeding years. The distribution will be 100 lakhs for the Central Division, 40 lakhs for the Southern Mahratta Country, 100 lakhs for the Radhanpur State and Mahi Kantha, 50 lakhs for the Panch Mahals and the remainder for the Ahmedabad and Kaira Districts. For the Panch Mahals, a supply of 40 lakhs has been provided by the Collector additional to the operations of Government. The facts that in Gujarat most of the cattle are stall-fed and that it is not the custom to store fodder have added greatly to the present needs. Perhaps there is here a lesson which adversity may teach us. The Government grass is being supplied to cultivators at a uniform rate of Rs. 12 per 1,000 lbs. except in Kaira and Ahmedabad where the rate is Rs. 12½. These rates are considerably less than those charged by private dealers and much less than the cost price to Government. Government have also helped cattle owners to transport about 15,000 cows from the Ahmedabad and Kaira Districts to the Surat Dangs, and 20,000 head, mainly from Talukdari villages, have been sent to the Gir forests in Junagadh. Cattle kitchens have been established by the Collector of Ahmedabad which, as I can personally testify, are doing very good work.

Government Help.

By giving free grazing, liberal grants of tagai for well irrigation, special allotments for improving water-supply, and grain compensation to Government servants in 17 out of 25 Districts of the Presidency including Sind, Government have endeavoured to meet other requirements arising from the situation. The concession of railway rates for grass at less than half the normal freight charge is a boon which has been to some extent discounted by the inability of the Railways to handle the fodder traffic as rapidly as the necessity demanded. The operations both of Government and of private agencies have thus been hampered, and it is natural that there should be complaints. I can assure this meeting that the Railway Companies, to which we have strongly appealed, have done their best; but, partly by reason of shortage of wagons, and partly in the case of the B. B. & C. I. on account of shortage of water for the engines, their transporting power has not proved equal to the occasion. I believe that conditions are distinctly improving; but we may note the fact that in India concurrent demands upon the railways for which their equipment is not adequate may easily arise.

From what I have said, you will, I am sure, feel that we have dealt with the prevailing scarcity with promptitude and a deep sense of our responsibilities to the people. Yet there is work to be done for which Government Agency is not perhaps best suited, and I turn with pleasure to the activities of private philanthropists. The Bombay General Famine Relief Fund was started on the 30th October last and it has collected Rs. 1,34,754.

Most Pressing Need.

The Managing Committee found that the most pressing need was to save cattle and it has expended Rs. 1,46,900 in the purchase of 113 lakhs of pounds of fodder. The difficulty of securing railway transport has been severely felt and has hampered the work of the Committee. In consequence local fodder at higher cost has been utilized to some extent; but the centres of such supply are few and the Committee find that the cry for more fodder and for more money to buy dear fodder is growing. Human relief has not yet been required on a large scale but a sum of Rs. 20,000 has been allocated mainly to meet the needs of Purdanashin women, the old, and decrepit, and those whose customs forbid them to go to relief works. In distributing this form of relief in Palanpur State and Agency, four lady volunteers have given valuable assistance in seeking out Purdanashin women and their children. Members of the Servants of India Society have also worked with admirable zeal, purchasing nearly 75,00,000 lbs., collecting funds in Northern India amounting to more than Rs. 14,000, and organizing means of distribution through the agency of local Committees.

Other corporate bodies in Bombay have contributed Rs. 2½ lakhs and there have been private subscriptions of considerable amount which have gone to the afflicted districts. The Indian People's Famine Trust at Calcutta has generously forwarded Rs. 1 lakh, and the Sheriff's Anna Fund has reached about Rs. 38,000. The General Secretary states that the Managing Committee of the Central Famine Relief Fund has now practically expended all it. resources and is in pressing need of further assistance; but I believe that already contributions have begun to come in, and I have this morning received Rs. 500 from a kind friend which I shall hand to the Committee.

Private Charitable Relief.

The Wadia Trustees, with whom I have been in frequent communication, applied to Government in September to be allowed to utilize for the preservation of cattle the sum of Rs. 15,000 which they had generously promised to place at our disposal annually for Veterinary services, and later they set apart Rs. 1 lakh for charitable relief, utilizing the help of the Servants of India to obtain information as regards the Districts of Ahmedabad, Kaira and the Panch Mahals and later Kathiawar. The Commissioners and Collectors, the Agent to the Governor in Kathiawar and the Political Agents of Halar and Jalawar Prants gave them willing help and guidance. The Trustees were anxious to prevent overlapping of effort and to supplement the work of Government where it was possible. They realized fully that promiscuous relief was undesirable and that healthy and useful cattle must be the first object of their aid. They, therefore, undertook to save 1,000 plough bullocks in Kathiawar and to support the cattle kitchens, where useful cattle only are received, in Gujarat. In all they have secured nearly 168 lakhs of pounds of fodder at a cost of Rs. 1,09,250 which they have distributed partly free (71¼ lakhs of pounds) and partly as cheap grass (77¾ lakhs) in Ahmedabad, Kaira and Panch Mahals and Kathiawar. In addition they have allotted 8 lakhs of pounds as cheap fodder to the Co-operative Credit Societies in these three British Districts. The effect of these operations, supplementing those of Government, has been to keep down the local prices of fodder materially and this has been an indirect gain of much importance. The Trustees have so far mainly confined their efforts to the saving of cattle, but they have supplied clothing for the poor people on relief works in the Panch Mahals and Kathiawar, and in co-operation with the officers of the Salvation Army they have provided wells in places which were suffering from want of water

and also meals for poor children. They inform me that "no information could be more reliable and no Agency more honest" than that of the Salvation Army, which I can well understand from my knowledge of that admirably organized body.

In Kathiawar more than Rs. 35,000 have been collected locally. At present human relief has not become urgent, and efforts have been concentrated upon the cattle. A strong Committee with the Agent to the Governor as President has been appointed at Rajkot to administer any charitable funds that may become available. The Administrator of Junagadh has worked strenuously and with marked success, in obtaining fodder from the Gir Forest, where he is now employing 1,300 men ; but this supply must shortly cease. In Kathiawar generally, I believe that the situation is well in hand, but I fear that a considerable loss of cattle is inevitable. Here also, as elsewhere, we cannot feel sure that human distress will not develope somewhat rapidly before the monsoon.

Central Funds Needed.

From this statement of facts and figures you will have gathered a general idea of what has been and is being done, and you will realize that the Central Fund urgently needs assistance. The number of cattle that can be saved is really a question of money and transport. We have still four months to face before fodder in large quantities can grow in the affected districts. As regards transport, the facilities are improving ; but probably about 1½ million head of cattle are wholly or partly dependent upon such help as can be provided, and a large portion of these animals are supremely valuable to the cultivators. Human needs, which appeal most strongly to our hearts, are much more difficult to estimate and in certain cases to relieve. Relief works which Government are ready to start the instant they are required can effectively deal with want of a certain kind ; but we all know that there are classes which may derive no benefit from these measures, which are difficult to reach and which may suffer in silence. The good lady workers, who have investigated such cases, report that in one Thana out of 123 persons relieved there were more than 50 widows over 55 years old, and 14 of them were blind widows with children dependent on them. They say that : "In many cases we found that the condition of women was utterly destitute, partly owing to their age and condition of life." And they add "What struck us was the unwillingness of the women to receive our help and it was after much inducement and assurance that the help given to them would not be made known to the other villagers that they accepted our assistance." Those few words speak volumes. They indicate desperate needs, which Government agency may never reach. They clearly point out a direction in which philanthropy can be blessed, and they will, I am certain, appeal powerfully to this meeting. The situation with which we are trying to cope has produced harmonious co-operation among the workers, official and non-official, who have realized that there is room for all and that they have need of each other. This is a happy circumstance and it is also a guarantee that the funds which may be placed at the disposal of the Bombay General Committee will be spent with a minimum of waste. I hope that I have not detained you too long. Among the many generous and warm-hearted citizens of Bombay it is only necessary to let a public need be well understood, and one can securely count upon strong support. The meeting will shed light upon the needs that exist and that must come. I have no doubt that funds will be forthcoming to put fresh vigour into a work of mercy, to carry new hope to the afflicted people and to emphasize the growing sense of brotherhood which is slowly but certainly transforming the life of India.

Committee's Report.

Mr. Purshotamdas Thakordas, the general honorary secretary of the Fund, then read the following report :—

Towards the end of last October, when the inhabitants of North Gujarat, Kathiawar and Cutch gave up all hopes of the rains, a large number of people from the famine-stricken are as came to Bombay to collect subscriptions for the preservation of cattle in their districts.

Several lists went round, and within a month it was felt by many of the leading citizens to Bombay that the formation of a Central Committee in Bombay for the collection of funds for the organization and distribution of relief was very desirable. About fifty leading gentlemen of the different communities met together and the Bombay Central Famine Relief Fund was started on the 30th October 1911. Owing to the Royal Visit festivities and the Delhi Durbar the work of collection was delayed in a measure; but the the time at the disposal of the Committee was, however, utilized in getting in touch with the official on the spot and in securing fodder which has since then risen in prices nearly 15 to 20 per cent., and in some cases by 50 per cent.

Up till now the Committee have collected Rs. 1,92,357-3-3 and bought 11,300,000 lbs. of fodder, costing Rs. 1,46,900. The concession given by Government in freight charges of fodder to the affected areas has proved a veritable boon to the suffering cattle by greatly reducing carriage charges; but it is to be deeply regretted that, owing to extraordinary pressure on the railway traffic, due to causes, some of which were unforeseen, it has not been possible to fully avail of this boon till now. In some cases it has been most touching to find, that, in spite of people having the fodder ready at one end, the cattle at the other end, are literally starving for same, the connecting link, *viz.*, the railway line not being available for service. And this most painful delay has caused much deterioration among the cattle concerned. It is only fair to the railway company to mention here that they have always been sympathetic in their treatment of famine traffic, and having shown their willingness to help the situation without seriously dislocating their normal traffic.

In view of this difficulty in the carriage of fodder, the Managing Committee of this Fund have, wherever available, utilized, even though at a little higher cost, fodder on the spot; such centres, however, have been few and the cry for more fodder and for more money to buy dear fodder with, is growing day by day.

A Lakh for Cattle Relief.

Out of Rs. 1,34,705 voted till now for cattle relief Rs. 25,000 have been granted for purchase of cattle to the Talukdari Settlement Officer, Ahmedabad, and Rs. 10,000 have been remitted to the Political Agent, Palanpur, for purchase of fodder in his thanas, which are very distant from the railway line and where fodder is yet available. For the rest of Rs. 1,00,000, whenever a grant is voted, the officers in charge call for equivalent of the grant in hay. In the words of Captain Meek, Political Agent, Gohilwad, "grass—grass—grass is the fervid cry of the poor people, who cannot afford to buy it, and who helplessly watch in horror of an awful death, slowly and silently eat away the lives of their dumb and uncomplaining companions." As said above, the Managing Committee have till 16th March voted Rs. 1,34,705 to cattle relief; but in view of 1,500,000 cattle having been affected by the famine-stricken area, the relief afforded by this fund till now cannot be much. It is also to be borne in mind that the work of keeping up the cattle has to be continued for the next four months at least taking the next monsoon to be a normal. As to human relief, although the pinch has not yet been very acute, it is feared generally that it is likely to show itself in the near future and increase in intensity as we approach the monsoon. Pardanashin women, the old, aged and decrepit and those whom custom forbids to work on the relief works, have been the special care of the Managing Committee, and the sum of Rs. 22,350, which has been voted out till now for human relief, has been devoted to the relief of such principally. Four lady volunteers headed by Mrs. Ramabai Ranade of Poona toured in some parts of the Palanpur Agency and State and have done very useful work in distributing relief to Pardanashin women and their children particularly.

In the work of distribution members of the Hon. Mr. Gokhale's Servants of India Society, headed by Mr. G. K. Deodhar, have played a most important part. They have been exceptionally serviceable to the Committee in purchasing fodder to the extent of nearly

7,500,000 lbs. of good quality at cheap rates ; besides, the most humane and self-sacrificing manner in which they have been working in organizing the distribution of relief mostly through local committees—to say nothing of the collection of funds (contributions through them would amount to nearly Rs. 14,000 from U. P., Punjab, etc.)—entitle them to the best thanks of this Managing Committee and of the public at large. A major portion of the affected areas is under the Native States and relief in certain cases is necessary and has been given to the people there. The Managing Committee of this Fund, however, require that before help from this Fund is applied for, the States responsible for the necessary measures of relief have done their best for the relief of the suffering cattle and the poor. This Fund is devoted principally to the care and upkeep of cattle that are useful and valuable and that constitute the only capital of the agricultural population and on the preservation of which the future of the ryot in the coming monsoon depends.

Handsome Contributions.

Though large grants have been sent out direct from Bombay to mitigate the famine distress, still the specific purpose of this fund, *viz.*, the supplementing of official aid by non-official relief through non-official agency has been fully recognized as will be seen from the following handsome contributions received which the Managing Committee desire particularly to note :— Indian People's Famine Fund Trust, Calcutta, Rs. 1,00,000 ; Social Service League (house-to-house collection), Rs. 14,100 ; Mr. Ichharam S. Desai, proprietor and editor of the *Gujarati* (One Anna Fund), Rs. 7,000 ; Mrs. Jamanabai N. Sakkai's collections, Rs. 2,000 ; balance of the fund for feeding the poor on the occasion of the Royal Visit through Messrs. Inglis and Ratansey Moolji, Rs. 3,000. Besides this, Rs. 11,000 have been received from charitably disposed persons in Northern India up to Peshawar, and the Managing Committee takes this opportunity of thanking all contributors, who have generously offered their money for help in the affected areas.

The Committee are aware of the several calls that have lately been made on the public of Bombay for charity. The affected areas lie closest to Bombay and after having watched the utility of their operations during the last three months, the Committee are fully satisfied as to the need of their help and also as to the good being done by same. They, therefore, beg to appeal to the public for more funds and in making this appeal the Committee are fully satisfied that they will be able to justify the confidence which the public have been pleased to place in them till now and which they hope will be continued for the next few months. I shall only add in conclusion in the words of a painstaking and sympathetic official from Kathiawar that " If help be given, pray it be given immediately, as the present position is critical."

An appended statement showed that the total contributions up to March 16th amounted to Rs. 1,92,357-3-3 ! the purchases of hay amounted to lbs. 11,300,000 ; and despatches of hay to lbs. 4,000,000. The following amounts had been expended in cattle relief :—Patri, Rs. 1,000 ; Amreli, Rs. 500 ; Sayala, Rs. 250 ; and Cutch, Rs. 1,500 ; total Rs. 1,34,705. In Cutch Rs. 2,500 had been spent in human relief.

Work of Famine Relief.

Mr. H. A. Wadya moved the first resolution : " That this meeting recognises the growing necessity for adequately helping the objects for which the Bombay Central Famine Relief Fund has been started and approves of the method of relief adopted by the Committee." Mr. Wadya said he was afraid the extent of the distress which the Committee had been striving to meet had not been fully realized by the public at large, either in Bombay or outside it. The objects of the relief fund were the preservation of cattle and the mitigation of distress among the poor ryots. The question of cattle relief had during the last few months become one of great urgency. His Excellency had already stated that nearly fifteen lakhs of heads of cattle were suffering from scarcity which had overtaken districts in Gujarat, Panch Mahals, and

Kathiawar. They would readily understand how great was the extent of distress among the cattle if he told them that to preserve every one of these poor animals would mean a cost of something like seven crores of rupees, and of that the Committee had only one and-a-half lakh. Mr. Wadya then proceeded to refer to the help given to the Committee in their work of administering relief by officers of Government, by the members of the Servants of India Society, founded by the Hon. Mr. G. K. Gokhale, and a Committee of Indian ladies, headed by Mrs. Ramabai Ranade. His Excellency had referred to the disappointment which they had no doubt felt at the inadequacy of railway assistance to carry fodder to the famine districts in Gujarat and Kathiawar. He was bound to admit that they must make allowances for exceptional conditions in which the railways found themselves at the present moment. But he could not help feeling an apprehension and expressing an apprehension on that occasion that the mighty roar of the powerful interests which lay behind the export trade in this country might not permit the feeble wails of their starving cattle and despairing ryots, and they hope that with the help of public opinion they would bring to the mind of the Government of India the necessity of their calling upon the Railway Board to meet more adequately the situation than at present. Nothing had been more painful to them than to find that while thousands of bales of fodder were lying idle on the railway yards, cattle were starving and dying and the railway authorities were helpless to do anything. He knew that every effort had been made by His Excellency to extend help to them and they were most grateful to him for it. But he was surprised when he read that morning in the report of the proceedings of the Imperial Legislative Council, that it was stated in that Council that no complaint had reached the Government of India of the inadequacy of railway facilities to take fodder to famine districts. He hoped the voice of this meeting would reach the ears of the Imperial Government and they would feel that the railways were not helping them. Coming to the question of human relief Mr. Wadya said happily hitherto their worst apprehensions had not been realised. They were thankful that there was not so much distress now as at one time they were led to apprehend. But he reminded those present that the worst months were still before them.

Very briefly Mr. Fazulbhai C. Ebrahim seconded the resolution, remarking that the only thing which remained for him to do was to urge them to generously help the Committee in their efforts, to help as far as possible, to mitigate the suffering of the distressed.

The Hon'ble Mr. Lalubhai Samaldas, who also supported the resolution, said he did not think anyone was justified in saying there was no famine and praised the work of the conscientious and energetic Secretary. "The only question for us now," said the speaker, "is not to talk much, but to pay, and I am sure the request that we are making will not be ignored."

Mrs. Jamnabai Sakai made a strong appeal in Gujarati to the people of Bombay for further funds.

Colonel Blowers.

Col. Blowers also supported the resolution: "It is my privilege," he said, "to occupy the position of Leader of the Salvation Army in Gujarat and the Panch Mahals, and as such I have the oversight of between five and six hundred villages, in which the S. A. operates; in the famine affected areas, and by virtue of this position I am brought closely in contact with the people, and have considerable first-hand knowledge of the present position relative to famine, and because of this fact, Your Excellency, I believe, it is expected that I should this evening not only support the resolution before the meeting, but make some direct reference to the cause which this meeting has met to consider. I would state, and very emphatically state, that I consider the representations made regarding the famine to have been, under, rather than overstated—in fact, as far as cattle are concerned, it would be difficult to paint the picture too black, and I fear the real facts, and the amount of suffering will never be fully known, especially to those who do not actually move among the people. I have just returned from a long tour in the Panch Mahals and the Kaira District, and I find the situation relative to the cattle,

daily growing worse, and I have no hesitancy in saying, hundreds of cattle are dying daily and thus the people and the country are losing one of their most valuable assets. This seems all the more distressing, when one remembers that in the districts almost adjoining the affected areas, there are great quantities of fodder, and yet owing to the railway difficulties and shortage of wagons—even though to a considerable extent, money is available for fodder—these difficulties seem to stand almost as an unsurpassable barrier between the living and the dead. To my certain knowledge there are over 80 lakhs of lbs. of fodder, bought and paid for, lying within 150 miles of districts where cattle are dying for want of fodder, and yet we cannot, owing to shortage of railway wagons, handle it. I do earnestly pray that some further and immediate steps may be taken for the removal of this barrier, and that the railway may in this serious crisis be able to fulfil its noble object, and the Government its purpose in being both a protective and a preventative agent, and thus mitigate the suffering and loss. I have seen something of the splendid organization of the Government R. W. and of these and the services of those associated with these relief operations, one cannot speak too highly, nor of the efforts of such charitable bodies as the W. T. F., and the efforts of the B. C. F. R. F.—yet notwithstanding these—there is still a great need for both cattle and human relief, and while relief for the cattle is for the moment of the greatest urgency, I am of opinion that the day is not far distant when we shall be faced with terrible human suffering that will be appalling. Our duty is to prepare."

Finally supporting the resolution, the speaker mentioned that the services of the organisation to which he belonged would, if of any use, be gladly placed at the disposal of the Famine Relief Fund.

Mr. C. H. Armstrong.

The Hon'ble Mr. C. H. Armstrong proposed the following resolution:—"This meeting earnestly invites the people of this Presidency and also in India generally to give their liberal support to the Committee of the Bombay Central Famine Relief Fund to enable them to continue their work of organising and distributing relief in the famine-stricken districts of North Gujarat, Kathiawar and Cutch." This resolution (said the hon. gentleman) or more correctly this invitation to subscribe to the Central Famine Fund follows naturally on the resolution that has just been agreed to, and in moving it I would specially call attention to the object of the resolution, which is to enable the Committee to continue the work of organizing and distributing relief in the famine districts. When I tell you that only a week ago the Committee had come to the end of their resources, you will understand how very urgent the present need is. If it had not been that a telegram was received on Monday evening last week from Calcutta advising that the Trustees of the People's Famine Fund had most generously voted a second donation of Rs. 50,000, the work of the Committee of the Central Famine Fund in Bombay would have come almost to a standstill. And if this should ever happen, it would indeed be most unfortunate, for after having kept alive a large number of plough cattle for a period of three months or more, it would indeed be disastrous if funds now failed and the good that has been done was thereby lost. The position, as we have already been told, is that help must be forthcoming for a further period of about four months, during which time, so far as I can see, the Fund can very well spend further two to three lakhs of rupees. The Bombay subscriptions so far amount to just under a lakh and have not, I think, been as satisfactory as they should have been. In saying this, I am not, however, overlooking for one moment the money that has been subscribed in other ways. Some large sums have undoubtedly been given and an effort has certainly been made to help and succour those who are in need. But more is still required, and I am convinced in my own mind that it is advisable for those who desire to subscribe to send their contribution to the Honorary Secretary of this Fund, by whom, with the help of the Committee, the money will be distributed under the most favourable conditions and to the best advantage. The work, as you will have seen from the figures that have been published, is mainly to keep alive the young and serviceable cattle, and to do this a very large amount of hay has been purchased. This hay is consigned to the Government officials in the districts by whom it is received and weighed over,

and after such portion as may be required for free distribution has been taken, the remainder is sold to people who are known to have cattle at prices which it is known they can afford, a precaution being, however, that no more than one day's supply is sold at any one time to any one man. From a trader's point of view it is extremely important that the cattle should be kept alive, not only in British territory, but in the Native States. In British territory Government, working under the provisions of the Famine Code, are doing all they can to alleviate distress.

Imperial Expenditure.

"You will have seen from the recent budget," added Mr. Armstrong, "that the amount falling on Imperial and Provincial Revenues for this work, direct and indirect, is over 60 lakhs of rupees, but a large sum is required for other purpose to supplement this, and the charitable public are now therefore asked to subscribe. So far as human relief is concerned there are many who owing to age, caste, or to purdah restrictions are unable to go on relief works, and unless money is forthcoming for their needs the distress amongst them, more especially as time goes on, will undoubtedly be very great. A sum of Rs. 20,000 has already been given for this purpose. The principal amount so far voted is, however, for the relief and preservation of cattle, and from a trade point of view this is most necessary. Although the money has gone largely to British territory, Native States have not been overlooked, and during the next three months a larger sum will no doubt be voted to these latter. I appeal, therefore, to the charitable public in Bombay to help this Fund. As everyone knows Bombay is largely interested in Gujarat, Kathiawar and Cutch. The ancestral home acres of many of those who live and work in Bombay are in these districts. Their friends and relatives are also there, and they themselves in many cases, I imagine, hope to retire there eventually: in fact, nearly every man of means in Bombay and many others have important interest in these districts. It is, therefore, most appropriate that Bombay should be asked to subscribe liberally to this Fund. From a business point of view there can be no doubt the whole district is a most important one, and if the cattle are allowed to die, as happened a few years ago, the provinces will be put back for a long period of time and this must react unfavourably on the trade of this city. Although perhaps lately trade in Bombay has not been so good as it might have been, still in some directions at the present time there is considerable prosperity, and I appeal to those wealthy millowners, many of whom are now again making money, to assist in this charitable and most necessary work. As regards the rest of India, I appeal mainly on the ground of humanity with, however, this one point in addition—that in the past, when, as we all remember, there were serious famines in other parts of India, Bombay subscribed liberally for purposes of relief and is prepared to subscribe again in the same generous way to relieve a famine in any part of this great country. I have had a good deal to do with the Central Famine Fund since it was inaugurated, and can assure you that the work is being conducted on the most approved lines. The Honorary Secretary, Mr. Purshotamdas Thackerdas, is well-known for his business ability and he is therefore a most excellent man for the work. So far as the Committee are concerned, I can only say that we are very greatly indebted to him for the time and attention he is giving to this most deserving charity. I hope this resolution will not only be passed unanimously but that it will bring to the Fund a large amount of money—sufficient to enable the work to be carried on until the next monsoon. Some of the letters received only the last few days from Political Agents and others are really most pathetic. The one cry apparently is "Grass and more grass for the cattle, sheep and donkeys." Undoubtedly in some parts animals are even now dying from starvation, and if we are to do our work thoroughly we must do it at once. I make this appeal, therefore, in full confidence that contributions will be quickly and generously given."

The Lord Bishop.

The Lord Bishop of Bombay, in seconding the resolution, said there was a danger arising from the fact that the distress was not so widespread as they had feared in the beginning of the

year. Those late rains which came very unexpectedly about the time of His Majesty the Emperor's arrival had saved them from a good deal of distress which was anticipated, and many people might say, " Oh ! there is not now a very large area which is in distress," and therefore having expected to be called upon for so much more, ended by giving less than was required. He thought that would not only be very unfortunate, but very unjust to those districts which undoubtedly suffered, and it was for that reason that it was most important they should image to themselves the real and serious distress which existed in the districts where there was famine. The second thing he desired to say was that the work had been well begun. " There is no doubt," said his Lordship, " that up to the present the Committee has done its work admirably. Now it does often happen that what is well begun is not carried through, because it is far more difficult to keep on doing a thing than to start it. It is all very well to say, ' Well begun is half done,' but it is the second half that the real difficulty lies in keeping up interest and it is for the second half of the work that we call upon you at this meeting. What has been begun has been done well, but it remains to be carried on to the finish with the same or even increased ardour.

" And now one general observation, I am glad to stand here as a member of the English community and also as a member of the Christian Church, I am very glad to find myself here pleading a cause which is common to all the communities in this country and of all the religions in it. It is the cause of the poor, of the helpless—not only men, but also beasts. And not only that, but also here we say this is a great Empire, and in it, it is true as in a small family or a small State that if one member suffers all the members suffer with it, and we stand asking you and ourselves and calling upon ourselves to assist others who are members of this great Empire. However separated they may be from us in race, religion or caste, it does not matter ; they are here appealing to us as members of one Empire and as persons in need. And because of the heart of pity which belongs to our common humanity and because of the heart of honour which belongs to our common Empire, let us help them."

Mr. Jehangir B. Petit and Mrs. Laxmibai Ranade supported the resolution, the latter addressing the meeting in Marathi.

Mr. G. K. Deodhar.

The resolution was also supported by Mr. G. K. Deodhar. " I must be very clear," he said, " that the funds at our disposal are very inadequate. Demands are pouring in from all quarters for the relief of both cattle and human beings. The cattle have actually begun to die. Agriculturists who love their cattle, as tenderly as they do their children, have tried their best to save them by giving them roots of last year's grass and leaves of trees. But alas the moment of dire need has come and they are completely despaired. There is the cry for fodder from the whole of the affected area, and human beings also need our help, and therefore the question now before us is how to find the necessary sinews of war. If you want us to do our work further, allow me to tell you that the need of the situation is three-fold : (1) money ; (2) grass ; and (3) railway wagons. As regards the first it must be decided by you as to how this money should come forth. How money is urgently needed can best be seen from the few instances which I shall quote with your permission. First the Kathiawar Central Famine Relief Committee has framed its needs very moderately and has asked for at least two lakhs and fifty thousand Rupees, the two lakhs being for cattle and the fifty thousand for human beings. This, according to Mr. Hill (Agent to the Governor), is a very moderate estimate, and not a pie could be cut therefrom. But what has the Committee got to meet these requirements ? It has got barely ten thousand rupees and has wisely cut its coat according to its cloth. But of what avail will this coat be when it could not cover the whole body ? Similarly the Taluka Committees in the Panch Mahals need at least seventy-five thousand rupees among themselves. But we could give them only Rs. 30,000. Besides these demands the Collectors of Kaira and Ahmedabad, who are making strenuous efforts to save the cattle, the Talukadari Settlement Officer (Mr. Tupper), and the Political Agents of Palanpur and Mahikanta Agencies. (The Mereweathers) and Cutch whose distress is not yet sufficiently

ventilated—all these require large funds to be placed at their disposal. If therefore funds are forthcoming partial but effective relief will surely be given in the areas that are now in the grip of famine. Now the resolution proposes that funds should come from the citizens of Bombay particularly, and from the people of the Bombay Presidency and of the other Provinces in India generally. As for Bombay, a liberal response has been given but considering its wealth and its position larger and more substantial contributions are expected. Surat, Broach, Poona and Dhulia have sent small contributions but not surely worthy of their importance. As for the other Provinces, there has been a good response to our appeals from places like Lucknow, Cawnpore, Allahabad, Benares, Agra, Meerut, and Gorakhpore in U. P. and Lahore and Peshawar in the Punjab. But I surely think that if the other Provinces will sufficiently recognise the degree of assistance which Bombay renders in the hour of the need, they will feel that our claim upon their sympathy is quite just. It is very gladening to note that contributions have come even from women in the villages in the distance Provinces and if serious efforts were made to collect more funds a substantial amount will be collected.

"The most interesting and encouraging feature of this year's famine relief work is the spirit of cordial co-operation between the officials and the non-officials, and if only the railway companies will join us with that spirit the concession in railway freights which Government has given so generously and which has been the great saving factor of the situation, and the efforts which the non-official agencies are making to alleviate the bovine and human distress will prove fully useful. This then is the brief review of the situation as it obtains to-day, and if we all, the Government, the public and the railway authorities make strenuous efforts to co-operate with one another, the situation which is already very anxious will be relieved much of its tension."

The resolution was carried.

Mr. N. S. Glazebrook.

Mr. N. S. Glazebrook proposed:—"That this meeting votes its cordial thanks to the Board of Management of the Indian People's Famine Trust, Calcutta, for their generous help to the Bombay Central Famine Relief Fund, and prays that such help will be continued while the necessity lasts for the relief." "This is a resolution," he said, "which I feel sure will meet with the support which it so thoroughly deserves, and you will agree with me it is only right we should show our gratitude to the Managing Board in Calcutta for the liberal grants they have so far sent to this Fund. The first provision was Rs. 50,000, and it arrived at a time when this Committee was just commencing operations. It enabled the Committee to undertake some large contracts for hay which since then have all been delivered and distributed in the distressed districts. The second provision was also Rs. 50,000, and came at a most opportune time. Our fund then was getting exhausted, and when the Committee learned that this grant was coming from Calcutta they at once continued the work of buying more hay, which in due course will be transmitted to the distressed districts and will no doubt be gratefully received there. The question now is—'When is the third grant coming?' The Committee of management in Calcutta practically told us that if we could convince them that there is an urgent necessity for a further grant, and also—and more important—if we could also show them that the public of Bombay are doing their duty in attempting to relieve the distress in the famine districts, a further petition to the Calcutta Committee will be considered and they hope they will be able to send us something more. It seems to me, therefore, very necessary we should now keep our shoulder to the wheel. We have commenced well, and there is no occasion for us now to relax our efforts. Let us show our friends in Calcutta we are doing our best, and when they realise this I feel quite sure they will have little doubts in their minds that it is an urgent necessity and I trust a further appeal to them will not be received in vain."

Sir Cowasji Jehangir seconded the resolution. He said famine took place in most parts of the world, but there was no country which suffered more frequently from it than poor India.

Therefore they could not be too grateful to H. H. the Maharaja of Jeypore for founding a permanent famine fund by contributing to it a princely donation of fifteen lakhs of rupees. He sincerely hoped that the trustees of the fund would give them further help.

The Hon. Mr. Manmohandas Ramji supported the resolution, which was carried.

On the motion of Sir Bhalchandra Krishna, seconded by Mr. T. W. Birkett, a hearty vote of thanks was accorded to the Sheriff for convening the meeting.

Mr. Narotum Morarji Goculdas after thanking the meeting for their kindness stated that the two-anna fund which he started two months ago had now amounted to Rs. 39,500, and he took this opportunity of thanking each donor to the fund. He also acknowledged his thanks to a large number of medical practitioners for their co-operation and also to Mr. Vatchagandhi, editor of the *Sanj Vartman*, for a cheque of Rs. 6,000, which he had raised in connection with this fund.

Vote of Thanks.

The Hon. Mr. H. R. Greaves moved : That the best thanks of this meeting be tendered to His Excellency the Governor for his kindness in presiding at this meeting and for his great and constant interest in the work of the Bombay Central Famine Relief Fund. Mr. Greaves said he had some pleasant information to give to the meeting. They had heard several speakers speak about the defects of the railway. He had pleasure to inform them on the authority of the Traffic Manager of the B. B. and C. I. Railway that the whole of the Government fodder would be carried to its destination before the end of April. (Applause.) Having stated that he would put the proposal to the meeting, he thought very few words were required from him on that point. They all knew that His Excellency had taken the trouble to visit the famine-stricken districts to see for himself everything that was required to be seen. He was sure he had only to put the resolution to be carried with acclamation. (Applause.)

Mr. Dharamsey Morarji Goculdas seconded the resolution, which was put to the meeting by the Hon. Sir Pherozeshah and carried with acclamation.

His Excellency made a happy little speech in acknowledging the vote of thanks. "I am not quite sure," he said, "whether I may be regarded as a citizen of Bombay or not. I am afraid that is a legal question which it may take the High Court a very long time to determine, but I can assure you I feel exactly like a citizen and I would not have been absent from this meeting on any account. The Hon. Sir Pherozeshah Mehta drew a distinction between the Governor and Sir George Clarke. I am afraid those two people are sometimes very closely associated, but I hope you will think of me as the Governor only when I do something for your good which you don't like, but at other times—and especially when I am gone—I hope you will think of me only as your friend, who came out to India to do the best he could for you."—*Times of India, 20th March* 1912.

APPENDIX D.

	Rs.	a.	p.
The Indian People's Famine Fund Trust, Calcutta (contribution in three instalments)	1,50,000	0	0
List of Donations received for the Bombay Central Famine Relief Fund.	1,50,000	0	0
His Excellency Sir George Sydenham Clarke, Governor of Bombay... ...	500	0	0
Mr. Icharam Suryaram Desai (by collection in "One Anna Fund" in the columns of "The Gujrati")	* 18,886	3	0
Social Service League, Bombay (by house-to-house collection)	19,025	0	0
Servants of India Society (by collection in India)	† 9,541	3	0
Mr. Ratan J. Tata	10,000	0	0
From the Famine Fund of 1908 for relief of Hindu Widows and Orphans (through Mr. Lala Lajpat Rai)	6,000	0	0
His Highness the Nizam	5,000	0	0
His Highness Sir Bagvatsinghji, G.C.S.I., Thakore Saheb of Gondal	5,000	0	0
Miss Hamabai F. Petit	5,000	0	0
Indian Pearl Merchants of Paris (£ 300 and Rs. 26)	4,482	5	8
Mrs. Jamnabai Sakkai (from her collection)	4,000	0	0
The Bombay Kariana Bazar Association	4,200	0	0
From the surplus of the Fund for feeding the poor on the occasion of the Royal Visit (through Messrs. D. M. Inglis and Ratansey Moolji)	3,403	15	2
The Bombay Pinjrapole	3,000	0	0
Messrs. Morarji Gokuldas & Co....	2,500	0	0
Sir Shapurji B. Broacha, Kt.	2,500	0	0
The Bombay Grain Merchants' Association	2,500	0	0
Messrs. Khimji Vishram & Co. (Rs. 1,750 and 750)	2,500	0	0
The Rangoon Famine Relief Committee	2,210	0	0
The Bank of Bombay	2,000	0	0
The Bombay Pearl Merchants' Association	1,500	0	0
Mr. Vijbhukandas Atmaram	1,500	0	0
Sir Dorab J. Tata, Kt.	1,500	0	0
Mr. Khetsey Khaisey	1,500	0	0
Mr. Hurgovandas Mulchand (Rs. 150+250+750+350)	1,500	0	0
Messrs. Currimbhoy Ebrahim & Co. (Rs. 1,000) ... ... Sir Currimbhoy Ebrahim, Bart. (Rs. 500)	1,500	0	0
Mr. Moolji Damodher (for two wells)	1,400	0	0
Balance of Sir Shapurji B. Broacha Entertainment Fund (through Mr. Narottum Morarji)	1,143	2	6
Mr. Ramnarayan Harnandrai	1,101	0	0
The Hon'ble Mr. H. R. Greaves	1,000	0	0
Rao Saheb Sir Vussanji Tricumji Moolji, Kt.	1,000	0	0
The Hon'ble Justice Mr. G. S. Rao	1,000	0	0
The Hon'ble Mr. G. K. Parekh	1,000	0	0
Mr. H. A. Wadya	1,000	0	0
Messrs Killick Nixon & Co.	1,000	0	0
Mr. Purshottum Vishram Mavjee	1,000	0	0
Messrs. Nowrojee Wadya & Sons	1,000	0	0
„ Meherwanjee and Hormasjee Cama	1,000	0	0
„ Ralli Brothers	1,000	0	0
„ James Finlay & Co., Ld.	1,000	0	0

* Total collection through Mr. I. S. Desai is Rs. 19,282-3-0, but out of this sum Rs. 396 have been carried to the Cow Relief Fund account.

† Total collection through the Servants of India Society is Rs. 16,941-3-0, but out of this Rs. 7,400 have been shown in the list giving the names of the donors separately.

Subscription List—*contd.*

	Rs.	a.	p.
Messrs. Mitsui Busan Kaisha, Ltd.	1,000	0	0
„ W. and A. Graham & Co.	1,000	0	0
„ David Sassoon & Co., Ltd.	1,000	0	0
„ The Bombay Co., Ltd.	1,000	0	0
„ Volkart Brothers	1,000	0	0
„ Wallace & Co.	1,000	0	0
From the family of the late Soonabai Jamasjee Cawasjee Padshaw (3rd day ceremony)	1,000	0	0
Mr. Lala Mathuradas (for Brahmin relief)	1,000	0	0
Sir Jacob Sassoon, Bart.	1,000	0	0
Messrs. Forbes, Forbes Campbell & Co., Ltd.	1,000	0	0
From the Trustees of the late Mr. Ardesir Hormusjee Wadya	1,000	0	0
Re: Suit No. 114/1912 (through Messrs. Tyabjee Dayabhai & Co.)	1,000	0	0
The Khand Bazar Association	1,000	0	0
From Messrs. Abdul Hussain A. Peerbhoy and Cowasji Jehangir, Honorary Secretaries, Matheran Annual General Sports' Committee	655	0	0
Mr. Tribhovandas N. Malvi	551	0	0
Messrs. Thackersey Moolji Sons & Co.	501	0	0
„ Kalidas Dharamsey & Co.	501	0	0
Mr. Harnandrai Surajmal	501	0	0
In memory of Sir Jamsetjee Jeejeebhoy, Bart. IV	500	0	0
Sir Jamsetjee Jeejeebhoy, Bart. V	500	0	0
The Hon'ble Sir P. M. Mehta, K.C.I.E.	500	0	0
Mr. Narayandas Purshottumdas	500	0	0
Mr. Amichand Motichand	500	0	0
Mr. Bhulabhai J. Desai	500	0	0
The Hon'ble Sir Henry Procter	500	0	0
The Hon'ble Mr. Manmohandas Ramji	500	0	0
Messrs. Prier de Saone & Co.	500	0	0
From a friend (through H. E. the Governor)	500	0	0
Messrs. Gaddum & Co.	500	0	0
From the Treasurer, Lodge Imperial Brotherhood	500	0	0
The National Bank of India, Ltd.	500	0	0
The Chartered Bank of India, Australia & China, Ltd.	500	0	0
The Yokohama Specie Bank, Ltd.	500	0	0
Mr. Jamsetjee Ardesir Wadia	500	0	0
Messrs. Gokuldas Madhavjee & Co.	500	0	0
„ Gordhandas and Mulraj Khattau	500	0	0
The Atlas Assurance Co., Ltd.	500	0	0
The Hon'ble Mr. Lallubhai Samaldas	500	0	0
Annonymous (from a Hindu, Rs. 100 + 400)	500	0	0
Mrs. Holden (through Mr. Bardford) £ 30	447	10	9
The Mahajan of Umbergao (through Mr. Tribhovandas)	438	0	0
Collection through Mr. Lala Lajpatrai	364	8	3
Sir Bhalchandra Krishna, Kt.	350	0	0
Collection at the Bombay Club	350	0	0
From Indian residents in London, Edinburgh and Manchester (through the Hon'ble Mr. G. K. Gokhale) C.I.E.	330	0	0
From Mr. Daruwalla (collected by him in the Small Causes Court)	324	6	0
Mr. Framji Hormusji Bomanji Setna	301	0	0
The Hon'ble Chief Justice Sir Basil Scott, Kt.	300	0	0
Rao Bahadur Vussanjee Khimji	300	0	0
Messrs. Bradbury & Co.	250	0	0

Subscription List—*contd.*

	Rs.	a.	p.
Messrs. Cox & Co.	250	0	0
„ Breul & Co.	250	0	0
„ Lyon Lord & Co., Ltd.	250	0	0
„ P. Chrystal & Co.	250	0	0
„ Jivanlal Pannalal & Co.	250	0	0
„ Madhavji Kamdar and Chhotubhai	250	0	0
„ Sorabji and Cawasji Dadabhoy Dubash	250	0	0
„ Jivanchand Lallubhai & Co.	250	0	0
Diwan Bahadur Govinddas Chaturbhujdas (Madras)	250	0	0
Mr. Tribhovandas and Sir Jagmohandas Varjeevandas	250	0	0
Mr. Puranmal Gulji Singhani	250	0	0
Mr. H. C. Coyaji	250	0	0
Mr. Lallubhai A. Shah	250	0	0
Mr. S. R. Bomanji	250	0	0
Mr. Bhogilal Veerchand Deepchand	201	0	0
Bai Dahibai, widow of Sheth Veerchand Deepchand, C.I.E.	201	0	0
The Marwari Brokers of Linseed	201	0	0
Messrs. Dalshukh and Kantilal Wadilal Veerchand	201	0	0
Mr. Ratansey Moolji	201	0	0
Mr. M. R. Jardine	200	0	0
The Hon'ble Sirdar Nowroji Pudamji, C.I.E.	200	0	0
"Gentleman"	200	0	0
Mr. Bhaidas Narottumdas	200	0	0
Mr. Bhukhandas Govindjee	200	0	0
Messrs. Weld & Co.	200	0	0
Dr. Ramchandrarao Narsingji of Poona	200	0	0
Mrs. Surajbai Chandulal Atmaram Kaji (for a well and trough)	200	0	0
The Hon'ble Mr. M. B. Chaubal, C.S.I.	200	0	0
The Hon'ble Mr. Chimanlal H. Setalwad	200	0	0
Mr. Ishwerdas Laxmidas	200	0	0
"T. J. S." (through the Hon'ble Mr. Parekh)	200	0	0
Messrs. Wassiamall Assomull & Co.	175	0	0
Mr. Dayabhai Sankerbhai Patel, Lammu British East Africa	160	0	0
Messrs. Von Gosen & Co. (Anvers) Guineas 10	157	8	0
"A Parsi gentleman"	151	0	0
Mr. Anandji Nanji	151	0	0
Mr. Revashanker Jagjivan	151	0	0
Mr. Daji Abaji Khare	150	0	0
Mr. Merwanji D. M. Jijibhoy	150	0	0
Mr. Harkisandas Jagjivandas	150	0	0
The Lord Bishop of Bombay	150	0	0
Mr. Nowroji Jivanji Readymoney	150	0	0
Messrs. Chandulal and Chhaganlal Dayabhai	150	0	0
Rao Bahadur Karamsey Damji	150	0	0
Mr. D. N. Bahadurjee	150	0	0
From the Collector of Broach (through *Times of India*)	131	10	0
A Sakhi Gruhastha	125	0	0
Mr. Rughunathdas Gopaldas	125	0	0
Mr. Altmore W. Robinson	120	0	0
Prof. and Mrs. H. V. Hilprecht	115	0	0
Mr. Cursetjee K. Santoke	111	0	0
In memory of Manjulabai	105	0	0
X. C.	105	0	0

Subscription List—*contd.*

	Rs.	a.	p.
From the Lady Superintendent, Chanda Ramji Girls' High School (collection in the school by Mrs. Surajbai Chandulal Kaji)...	104	4	2
Mr. Trimbak Jhinabhai	101	0	0
Mr. Manubhai Nanabhai...	101	0	0
Mr. Girdherlal Harilal Mehta	101	0	0
Mr. Sassoon E. Nissim	101	0	0
Rao Bahadur Krishnarao Muley, I.C.S. (Indore)	100	0	0
Mr. Purbhudas Jivandas	100	0	0
A Gujrati Pensioner	100	0	0
Mr. H. B. Tayabjee	100	0	0
Mr. S. G. Velinker	100	0	0
From the Committee Sadavarat, Dharamshala Fund Chhotalal and Gayaparsad (Cawnpore)	100	0	0
Mr. L. Napier	100	0	0
The Hon'ble Sir Richard Lamb, K.C.S.I.	100	0	0
Messrs. A. Moritz & Co.	100	0	0
In memory of mother Kursedbai Nanabhoy Spencer	100	0	0
Rao Bahadur Dayabhai Hurjivandas	100	0	0
Mr. N. V. Mandlik	100	0	0
Mr. Ratanlal Ranchoddas...	100	0	0
Mr. Framji Cowasji Cooper	100	0	0
Mr. V. M. Pakwasa	100	0	0
Messrs. Ardersir Hormasji Dinshaw & Co.	100	0	0
D. M.Vatchha Charity Fund	100	0	0
Mr. Haridas Jivraj	100	0	0
Dr. Bhajeker and others, Trustees to the balance of the Fund raised for the relief of the sufferers in the last Bombay riot	100	0	0
Mr. N. D. Daru	100	0	0
Messrs. R. H. Patuck & Co.	100	0	0
Mr. Ramji Dhanji Biana...	100	0	0
From the Punch, Nal Bazar Flour Merchants	100	0	0
Mr. W. S. Millard	100	0	0
The Hon'ble Mr. S. R. Arthur, I.C.S.	100	0	0
"D. C. T."	100	0	0
Mr. N. S. Glazebrook	100	0	0
A Sympathiser	100	0	0
Mr. Khimji Cooverji	100	0	0
Mr. Narandas Assurmal	100	0	0
In loving memory of Soona and Kaku	100	0	0
The Hon'ble Mr. C. H. Hill, C.I.E., C.S.I., I.C.S.	100	0	0
Mr. Kilachand Devchand	100	0	0
Mr. E. M. Carrel	100	0	0
Mr. Chunilal D. Saraiya	100	0	0
Messrs. Tribhovandas Mangaldas and Nanu Narayan Kothare, Trustees of the late Kahandas Narandas Charity	100	0	0
Mr. Muljee B. Barbhaya	100	0	0
From the Secretary, The Lodge Aryan...	100	0	0
Mr. S. E. Shellim	100	0	0
Mr. P. E. Percival	100	0	0
A Sympathiser	95	0	0
Mr. Cursedjee Hormasjee Desai (Collection by Indians of Navsari at Transvaal)	93	0	0
„ Pandit Vishveshwar Dayal (a wagon of hay)	92	2	0
„ Bhikabhai Laxmidas (Nadiad)	87	4	3

Subscription List—*contd.*

	Rs.	a.	p.
Mr. Keshavrao Balvant Dhavale (Poona)	85	0	0
,, Krishnalal M. Javeri	75	0	0
,, K. B. Wagale	75	0	0
,, Mangaldas M. Pakvasa	75	0	0
,, Narmadashanker P. Vakil	75	0	0
Messrs. Motichand and Devidas	75	0	0
Mr. B. D. Billimoria	75	0	0
,, Digvijayasingjee	75	0	0
From the Manager, "The Sindi" } Being collection in his paper	74	15	0
Do. do. }	64	4	0
Mr. Chelaram Dnyanachand	60	0	0
,, Motilal Narottamdas	60	0	0
Messrs. Sorabjee and Jamsedjee Khan	55	0	0
The Clerks and Mill hands of Whittle Mill (Broach)	54	4	0
From the Bhagwadi Caste Mandal (Karachi) per Mukhi Chandamal Mohandas.	52	6	0
Mrs. Bachubai Karsandas Kanji	52	0	0
From the Commissioner of Customs, Salt, Opium and Abkari (balance of P. Memorial Fund)	52	0	0
Messrs. Dinshaw Furdunjee and Bros.	51	0	0
,, B. N. Ginwalla & Co.	51	0	0
"Four Brothers"	51	0	0
Mr. Tehelram Girdhardas	51	0	0
,, Harmukhrai Govindram	51	0	0
,, Harmukhrai Amulakchand	51	0	0
,, Harnandrai Foolchand	51	0	0
,, Gulabrai Kedarmal	51	0	0
,, Fulchand Matumal	51	0	0
Mrs. Godrej Pudumjee	51	0	0
Messrs. Dallaporta and Patel	51	0	0
Mr. Rajendra S. Dalal	51	0	0
Bai Manekbai, widow of Meghajee Tulsidas	51	0	0
From Gholwad and Bodi Merchants (through Mr. Narottamdas Tapidas) ...	51	0	0
Mr. Mangoomal Satramsing (Shikarpur)	51	0	0
,, Hiralal Dayabhai	51	0	0
,, Thakordas A. Ghandy	51	0	0
,, Trikamlal R. Desai	51	0	0
,, R. K. Dadachanjee	51	0	0
,, Bhavanishai Kasiram	51	0	0
,, N. N. Shroff	50	0	0
Messrs. Minocher and Co.	50	0	0
Mr. Sarabhai Maganbhai Mody	50	0	0
,, Vishwanath P. Vaidya	50	0	0
Bai Hamabai, widow of Nasarwanjee Khursedjee Dadee	50	0	0
Mr. C. M. Cursetjee	50	0	0
,, Arthur Hill, C. I. E.	50	0	0
,, Cowasjee B. Sethna	50	0	0
,, Ganeshdas Devkaran	50	0	0
"H. A. B."	50	0	0
Mr. Thakordas Jagjeevandas	50	0	0
"Humble Being"	50	0	0
Mr. J. H. Irani on the day of Nowjot ceremony of his daughter	50	0	0
,, Narbheram Vanechand (Morbi)	50	0	0
,, Matubhai Karsanbhai	50	0	0

Subscription List—*contd.*

	Rs.	a.	p.
From the Treasurer " Lodge Cyrus "	50	0	0
Mr. Tapidas Dayaram	50	0	0
„ Cawasjee B. Sethna (2nd contribution)	50	0	0
Major H. Steen (20 + 20)	40	0	0
Mr. Eduljee Rustamjee Dadachanjee (Baroda)	35	0	0
Rao Bahadur Nagardas Narottamdas Nanavati...	31	0	0
" Khoda Bax " (10+10+10)	30	0	0
Mr. G. V. Hardikar(4-4-0 + 6 + 19-12) Hydrabad (Deccan)	30	0	0
„ R. J. Kapadia	30	0	0
„ Khushaldas Haridas...	30	0	0
Master Shanti Thakkar (Paris)	30	0	0
From the Staff of " Bombay Samachar " Office	27	0	0
Mr. Purshotamdas Karsandas Muljee	25	0	0
„ D. P. Shroff...	25	0	0
Parsi Architects of Bombay	25	0	0
" My Mite "	25	0	0
Mr. Keshavjee Harkisandas	25	0	0
„ Moreshwar W. Pradhan	25	0	0
From the Hindu Staff, " Bank of Bengal " (Bombay Agency)	25	0	0
Mr. J. P. Dastur	25	0	0
„ Rustamjee P. Broacha	25	0	0
„ Gangadas Motilal	25	0	0
„ Kersasp R. Dadachanjee	25	0	0
„ Radha Swami	25	0	0
Messrs. Haptoola Salebhoy & Co.	25	0	0
Mr. J. H. Kapadia	25	0	0
„ Ratanjee R. Desai	25	0	0
„ A. K. Donald	25	0	0
Miss Dhanbanu B. Kapadia (In memory of her deceased father)	25	0	0
Mr. Kekhusru Manekjee, Editor and Proprietor, " Bombay Samachar " ...	25	0	0
„ Hiralal R. Munim	25	0	0
„ Krishnajee Hari Kelker	25	0	0
" H. A. B. "	25	0	0
Mr. Premanand Kevalram	25	0	0
A Citizen	25	0	0
" T. "	25	0	0
Mr. Harkisandas Surdas	25	0	0
" H. A. B."	25	0	0
Mr. Thackar Meghjee Tulsidas Badai	25	0	0
„ Kalianrai Shanker Prasad	25	0	0
The Secretary, " Hindu Union" (Mombasa)	25	0	0
Mr. Shapurjee Manekjee (Degaum)	25	0	0
„ G. P. Varma (Nasik)	25	0	0
Messrs. Nandlal and Pranlal Laxmanbhai Thacker (Bhownagar)	25	0	0
Mr. Nanubhai Soma Narayan	25	0	0
„ Hirjibhai K. Dalal	25	0	0
" B. D. M "	25	0	0
Mr. Manekjee D. Kanga...	25	0	0
„ Rustam Adar Irani	25	0	0
„ Hormasjee Shapurjee Patuck	25	0	0
„ Fattechand Vishnidas (Quetta) (7-8-0 + 10 + 5)	22	8	0
„ Cursedjee M. Bhimadiwalla	20	0	0
„ Pherozshah B. R. Mody	20	0	0

Subscription List—*contd*

	Rs.	a.	p.
Mr. Manchashanker J. Vakil	20	0	0
Messrs. Ibrahim Mohamedali & Co.	20	0	0
Mr. Burjorjee Nowrojee Apkhatyar	20	0	0
,, Narandas Keshavjee Jasani...	20	9	6
In memory of Bai Khursedbai Shapoorjee Jivanjee (2nd contribution) ...	20	0	0
Mr. Jethalal Ramjee	20	0	0
,, Shapurjee Hirjeebhoy	20	0	0
,, Thackar Narandas Keshavjee Jasani	20	0	0
,, H. S. Chatfield	20	0	0
,, A. S. D.	20	0	0
,, Lakhamsey H. Meishari	20	0	0
In memory of Rustamji Jamsedji Jijibhoy	20	0	0
,, ,, ,, Soonabai Rustamji Jamsedji	20	0	0
,, ,, ,, Jivanji Manekji	20	0	0
,, ,, ,, Soonabai Jivanji	20	0	0
,, ,, ,, Khursedbai Shapurji Jivanji	20	0	0
Mr. Rustam Hormaz Irani	20	0	0
Collection through the Sub-Government Pleader (Bhiwandi)...	19	4	0
Mr. Pheroz J. Billimoria	15	0	0
,, Laldas Tribhovandas	15	0	0
,, B. D. Lam	15	0	0
,, F. H. Boyce...	15	0	0
Dr. B. S. Patker	15	0	0
Bai Adibai, widow of Dhanjee Naranjee (5 + 10)	15	0	0
Mr. B. Bazonjee	15	0	0
„ Har Bhagwan (Jammu)	15	0	0
Messrs. M. A. Roganwalla & Co.	15	0	0
Mr. Ranchoddas Dhanjee	15	0	0
Prof. O. V. Müller	15	0	0
Mr. Radhalal (Roorkey City)	15	0	0
Messrs. D. M. Shukla & Co. (Surat)	15	0	0
In memory of Dr. Meherwanjee Jamsedjee Hakim (Surat)	15	0	0
,, ,, ,, Mr. Framjee Pestonjee Odhanwalla (Surat)	15	0	0
Mr. Ganpatrai Kesardas (Peshawar)	15	0	0
A Parsi Gentleman	15	0	0
Messrs. Bechar Kalidas & Co.	15	0	0
Mr. Devidas Vithaldas	15	0	0
Messrs. B. Kalidas and Co. (Burma)	15	0	0
Mr. Chotalal K. Muljee	15	0	0
,, Behramjee H. Warden	15	0	0
,, Veerchand D. Javeri	15	0	0
,, K. M. Mowdawalla	15	0	0
A litigant, 5th Judge's Court	14	0	0
From the Staff of the D. T. S.'s Office, Rutlam	13	0	0
Mr. Hormasjee Dhanjeebhai Mulla	12	8	0
From the executors of late Dr. Keshavlal H. Ichapuria	12	8	0
Mr. H. Maneklal...	12	0	0
Messrs. M. B. Ghandhy & Co.	12	0	0
Mr. Tapidas Mayaram	10	0	0
,, Dharamsey Karsanjee	10	0	0
A Parsi	10	0	0
Mr. Jivanchand Narandas Porecha	10	0	0
,, B. B. Ranjee, Master (Karachi)	10	0	0

Subscription List—*contd.*

	Rs.	a.	p.
Mr. Jivandas Narandas Porecha...	10	0	0
A Parsi Lady	10	0	0
Mr. B. Devichand	10	0	0
,, Champaklal Chokhchand (Devgarh)	10	2	0
,, Laxmi Narayan, Proprietor, L. N. Press (Moradabad)	10	0	0
From a poor and unfortunate	10	0	0
A Sympathiser	10	0	0
Mr. V. G. Kurdile (Nasik)	10	0	0
,, M. H. K.	10	0	0
,, Shiv Kant Sing (Fyzabad)	10	0	0
,, Ranchoddas B. Patel	10	0	0
,, Punja Pacha (Gangpur)	10	0	0
,, Lilachand Girdhar	10	0	0
,, Thackersey Keshavjee	10	0	0
Mandvi Message Writers' Association	10	0	0
A Sympathiser	10	0	0
Messrs. Nanalal and Ratilal	10	0	0
A Sympathiser	10	0	0
A Gentleman	10	0	0
Mr. J. D. Vatcha	10	0	0
,, Utamram Lallubhai	10	0	0
,, Goolamalli G. Merchant	10	0	0
,, Goolamalli C. Mooljee	10	0	0
,, Hormasjee K. Santoke	10	0	0
,, Sorabji Ardesir Irani	10	0	0
A Parsi family	10	0	0
"B"	10	0	0
Mr. Ramlal, Head Clerk, Indore	9	14	0
From the Station Staff, Meghanagar	8	0	0
Collection through Mr. Chotalal Vithaldas	8	0	0
R. P. & Co.	7	8	0
Mr. Veerjee Bhagwan	7	0	0
,, D. V. Sanklia	7	0	0
,, Pestonjee P. Ragina	7	0	0
Bai Prankore, widow of Mayaram Samaldas	5	0	0
Mr. Chaturbhuj Bhavanidas (in memory of his deceased son)	5	0	0
,, K. Desai of Calcutta...	5	0	0
,, G. K. Gaurakshker	5	0	0
The Star Industrial Works	5	0	0
Messrs. Rajaballi Abdul Hussain & Co.	5	0	0
A Gujarati Grhistha	5	0	0
Mr. Prem Dayal (Gorakhpur)	5	0	0
,, Manekjee Ratanjee Davar	5	0	0
,, N. L. Dalal (Jetpur)...	5	0	0
,, R. B. Chinoy	5	0	0
,, Sham Sunder Lal Vakil (Manipuri)...	5	0	0
,, Gulajari Lal (Ajmer)	5	0	0
Mrs. Jadav Laxmi Keshavlal Jekisandas (Borsad)	5	0	0
,, Chandan Laxmi Lallubhai Parikh (Borsad)	5	0	0
Mr. B. M. Mody	5	0	0
A Gentleman (Sadra)	5	0	0
Mr. Maneklal Valjee	5	0	0

Subscription List—*contd.*

	Rs.	a.	p.
Mr. Mehta Maneklal Mangaldas Nalavala	5	0	0
„ Motilal Gangadas	5	0	0
„ J. Baptista	5	0	0
„ K. R. Koregaoker	5	0	0
„ S. J. Dalal	5	0	0
„ Jacob I. Apteker	5	0	0
„ M. V. Bhat	5	0	0
„ D. N. Khandwalla	5	0	0
„ B. V. Nerurker	5	0	0
„ V. H. Pradhan	5	0	0
„ Ardesir Bezonjee	5	0	0
„ Indra Narayan B.	5	0	0
„ S. B. Dadiburjor	5	0	0
„ I. J. Samson	5	0	0
„ M. K. Vesawewalla	5	0	0
„ M. F. Mulla	5	0	0
„ B. V. Kothare	5	0	0
„ F. B. Badshaw	5	0	0
„ T. V. Shah	5	0	0
„ J. D. Sukhia	5	0	0
„ G. V. Vaishnav	5	0	0
„ B. R. Lentin	5	0	0
„ R. C. Nazir	5	0	0
„ N. S. Devrukhker	5	0	0
„ Chotalal Jekisandas	5	0	0
„ N. S. Taraporewalla	5	0	0
"D. J. S."	5	0	0
Mr. Bhagvandas R., Engineer	5	0	0
„ Shambhuprasad G. Gandhy	5	0	0
„ Hormaz Aspandiar Irani	5	0	0
"Sal Mubarak"	5	0	0
Mr. Meherwanjee Bezanjee Panjnigara	5	0	0
„ Erwad Khursedjee Dosabhoy	5	0	0
„ Sorabjee Nasarwanjee Mehta	5	0	0
„ Dinshaw Meherwan Irani	5	0	0
„ Sheriar Ardesir Irani	5	0	0
„ Shiavax C. D.	5	0	0
„ Palanjee Nasarwanjee Frenchman	5	0	0
„ Pestonjee Pochajee	5	0	0
"Bande Khoda"	5	0	0
Mr. Ashrafi Lal Gupta	5	0	0
Sums under Re. 1 (as received from Sirdar Nowrojee Padumjee, C.I.E., of Poona)	4	12	0
From the priests of the Kadmi and Shenshai Anjuman's Agiary	4	0	0
Mr. Rustomjee Pallonjee Daruwalla	3	0	0
Sons of the late Mr. Kavasjee Hirjeebhoy, Driver	3	0	0
Mr. Sheriar Khodabax	3	0	0
„ Nanabhoy Cowasjee Khambata	3	0	0
„ P. R.	3	0	0
„ Gustasp Behram Khairabadi	3	0	0
„ Pestonjee Bomanjee	3	0	0
„ S. Gurdas Sing	3	0	0

Subscription List—*contd.*

	Rs.	a.	p.
Mr. P. Mani Ram...	3	0	0
„ P. Rajnath	3	0	0
"S. D. C."	3	0	0
Mr. Nand Gopal	3	0	0
„ Hargovind Purshotam Oza	3	0	0
„ Icharam Mayaram	2	0	0
A Zoroastrian	2	0	0
Mr. Satyaram Motiram (Benares)	2	0	0
„ B. Hira Nand	2	0	0
„ Manekchand	2	0	0
„ B. Gurudasmall	2	0	0
„ Dhanapatrai	2	0	0
„ B. Narayan Sing	2	0	0
„ Shiv Dayal Dubey (Kamalpur)	2	0	0
Mrs. Krishnabai Antrolker	2	0	0
Mr. Maneklal Vijbhukandas Danawalla	2	0	0
„ Maganlal Narandas	2	0	0
„ A. M. Mody	2	0	0
„ L. J. deLima	2	0	0
„ S. D. Jogleker	2	0	0
„ Motilal T. Dalal	2	0	0
„ Motilal N. Mehta	2	0	0
A Zoroastrian	2	0	0
Mr. Dinshaw D. Kapadia	2	0	0
„ Sorabjee Nowrojee	2	0	0
Mrs. P. C. Vesuwalla	2	0	0
„ B. B. Vesuwalla	2	0	0
Mr. Dorabjee Sorabjee Jivajee	2	0	0
„ Sheriarjee Dorabjee Patel	2	0	0
In memory of late Mr. Rustamji Framji Khajuri	2	0	0
Mr. Jijibhoy Edulji Wadia	2	0	0
Messrs. Framji and Burjorji Cowasji Leactmore	2	0	0
Mr. Nasarwanji Rustamji Ghadiali	2	0	0
In memory of my dead ones	2	0	0
In memory of late Mr. Pestonji Cowasji	2	0	0
Mr. Ardesir Bomanji Sethna	2	0	0
„ B. Sheo Sahai	2	0	0
„ Palanjee Lilavwalla...	1	0	0
„ A Jain (Tivory)	1	0	0
„ Motilal Chunilal Reshamwalla	1	0	0
From a teacher (Bhownagar)	1	0	0
Mr. Jamsedjee D. Master	1	0	0
„ Bezanjee Palanjee Master	1	0	0
„ Framroz J. Master	1	0	0
„ Pheroz Mencharjee Mehta	1	0	0
„ Dorabjee Hirjeebhoy	1	0	0
„ Nasarwanjee Manekjee Dalal	1	0	0
„ Irani Jamsed Hormaz	1	0	0
„ Dhanjeeshah Eduljee Mehta	1	0	0
„ Jehangirjee Meherwanjee Falapalan	1	0	0
„ Sorabjee Khursedjee Kaikobad	1	0	0
From a Zoroastrian	1	0	0

Subscription List—*contd.*

	Rs.	a.	p.
Mr. Dorabjee Khursedjee Ghadiali	1	0	0
„ Shapurjee Nasarwanjee Ataria	1	0	0
„ Sheriar Diniar Irani...	1	0	0
„ Meherwan Rustam Irani	1	0	0
„ Dorabjee Dadabhoy Khambata	1	0	0
„ Pestonjee Ratanjee Burdi	1	0	0
Bai Dhanbaijee G. Khambata	1	0	0
Mr. Irani	1	0	0
„ Dadabhai Manekjee	1	0	0
"Bande Khuda"	1	0	0
Mr. Dinshaw D. Writer	1	0	0
„ Jehangirjee Hormasjee Kanga	1	0	0
From a Zoroastrian	1	0	0
„ „	1	0	0
Mr. Ardesir Khudadad Irani	1	0	0
„ Pestonjee D. Ghaswalla	1	0	0
„ Ratanjee Framjee Kolhapurwalla	1	0	0
„ Jehangirjee D. Ghaswalla	1	0	0
„ Byramjee Burjorjee Khariwalla	1	0	0
„ Kaikobad Adar Irani	1	0	0
„ Kolhapurwalla	1	0	0
In memory of my dear ones	1	0	0
Mr. Pherozshah Framjee Nanporia	1	0	0
In memory of late Mr. Nasarwanjee N.	1	0	0
Mr. Rustam Sham	1	0	0
„ Nasarwanjee Bomanjee	1	0	0
„ Pestonjee Kuverjee Ataria	1	0	0
„ B. Ram Lal	1	0	0
„ B. Bhagawandas	1	0	0
„ N. Ramchandra	1	0	0
„ S. Mota Sing	1	0	0
„ Choudhari Amba Lal	1	0	0
„ S. Ajab Sing	1	0	0
„ B. Vaidya Sahai	1	0	0
„ Mahadev Prasad	1	0	0
„ B. Debi Prasad	1	0	0
„ B. Ram Prasad	1	0	0
„ B. Jagan Nath	1	0	0
„ B. Kunwar Bahadur	1	0	0
„ B. Radha Mohan	1	0	0
„ R. S. Patki	0	8	0
„ B. Karamchand	0	8	0
„ B. Divanchand	0	8	0
„ B. Hemchand	0	8	0
„ B. Shiv Charan	0	8	0
„ Temadas Harkoo	0	8	0
"One Sadhu"	0	8	0
Mr. B. Sambu Lal	0	8	0
„ B. Kashi Ram	0	8	0
Dharmapatni of Kahsi Ram	0	8	0
Mr. N. Uttamchand	0	8	0
„ Harichand Dalsukhbhai (Nadiad)	0	7	6
„ Pherozshah Cowasjee	0	4	0
Total Contributions ... Rs.	3,36,709	13	6

List of donations received to the Cow Relief Fund.

	Rs.	a.	p.
Goswami Shree Tikayat Gordhanlalji Maharaj	1,000	0	0
„ „ Goculnathji Maharaj	525	0	0
Mr. Icharam Suryaram Desai, Editor and Proprietor of "The Gujarati "(One Anna Fund)	396	0	0
„ Tribhovandas N. Malvi	350	0	0
Messrs. Chandamal and Chelaram	300	0	0
Bai Tulja Laxmi Bhaidas Jekisandas	251	0	0
Mr. Mulji Damodar	250	0	0
„ Narandas Thackersey Mulji	200	0	0
„ Balubhai Bhaidas	200	0	0
„ Khimji Cooverji	100	0	0
„ Amarchand Madhavjee	132	0	0
„ Valajee Velajee	132	0	0
„ Vanichand Popat (Morbi)...	108	0	0
„ Dharsey Morarjee	108	0	0
From a sympathising Parsi Lady	108	0	0
Mr. Thucker Kalidas Juthabhai	101	0	0
Through the Bombay Grain Merchants' Association	72	0	0
Mr. Nayak Bapulal Babhalbhai	60	0	0
„ Kurpal Doongersey	60	0	0
From the Choksy Bazar	60	0	0
Mr. Karsandas Thackersey Ravaji	60	0	0
Messrs. Bhaidas Karsandas & Co.	60	0	0
Mr. Thakordas Jagjivandas	60	0	0
„ Harkisandas Jagjivandas	60	0	0
„ Ratansey Kanjee	60	0	0
„ Raghunathdas Gopaldas	60	0	0
Mr. and Mrs. Harakhlal Hareedas	60	0	0
Mr. Haridas Tricumdas Premjee	60	0	0
„ Chaturbhuj Shivjee	60	0	0
„ Pragjee Vandravan	60	0	0
„ Jethabhai Govindjee	60	0	0
„ Karsandas Purshotam	60	0	0
„ Hiralal Motiram	60	0	0
„ Govindjee Amarsey Bhagat...	60	0	0
„ Ramdas Madhavjee Jeyasing	60	0	0
„ Dharamsey Pitambar...	60	0	0
„ Virjee Kanji Liladhar	60	0	0
„ Purshotam Pranvallabh	60	0	0
Messrs. Dwarkadas Narandas and Ramji Laxmidas	60	0	0
A Vaishnav and his wife...	60	0	0
Messrs. Thucker & Co.	51	0	0
Mr. Morarjee Veljee	51	0	0
A Gentleman	50	0	0
Messrs. Bhagavandas Bhavanbhai and Khimji Kara & Co.	50	0	0
A Sakhi Gruhastha	48	0	0
A Bhatia Gruhastha	48	0	0
Messrs. Mayashanker Thucker & Co.	48	0	0
A Lady	48	0	0

Subscription List—*contd.*

	Rs.	a.	p.
Mr. Tockersey Kanjee	48	0	0
,, Lakhamsey Khetsey...	48	0	0
,, Bhimji Pragjee	48	0	0
,, Kalyanjee Jayaram Naranjee	36	0	0
,, Vadilal Purshotum	36	0	0
,, N. M. Gandhi	36	0	0
,, Tulsidas Morarjee Ratanji	36	0	0
Messrs. Bhimjibhai Framjee Kavsa & Co.	36	0	0
A Gruhastha	25	0	0
Mr. Raghavjee Khimjee...	25	0	0
,, Vadimal Bhagmal	25	0	0
,, Haridas Premji (in memory of his deceased daughter)	25	0	0
,, Harjivan Dharsey	24	0	0
,, Kalidas Veerchand	24	0	0
,, Vrujlal Jivandas	24	0	0
,, Vussonjee Pitambar...	24	0	0
,, Coorjee Dharamsey...	24	0	0
,, Damodar Haridas	24	0	0
,, Kapurchand Ramchandra	24	0	0
,, Narandas Purshotam	24	0	0
,, Ramdas Deojee	24	0	0
,, Dwarkadas Kanjee Heerjee...	24	0	0
A Gentleman	24	0	0
Mr. Gordhandas Morarjee Doongersey	24	0	0
,, Kanjee Curson	24	0	0
Patel Tricumdas Gopaldas	24	0	0
Mr. Muljee Cursandas	24	0	0
,, Jamnadas Sunderjee...	24	0	0
,, Rattonsey Muljee	24	0	0
Bai Moghibai, wife of Mr. Girdhardas Jethabhai	24	0	0
Mr. Hemraj Kanjee	24	0	0
,, Hansraj Cursondas	24	0	0
,, Raghawji Anandji	24	0	0
,, Kanji Dharamsey	24	0	0
,, Gordhandas Ratansey	24	0	0
,, Kanji Karabhai	24	0	0
,, Morarji Velji	24	0	0
,, Motiram Jakisandas	24	0	0
,, Manecklal Vithaldas	24	0	0
A Gentleman	24	0	0
Mr. Roychand Hirachand	24	0	0
,, Valjee Dayal	24	0	0
,, Jagjivan Pragjee	24	0	0
,, Panachand Premchand	24	0	0
,, Mulchand Hirachand	24	0	0
,, Purshotam Laxmidas	24	0	0
,, Jagjivandas Kahandas	24	0	0
,, Jamnadas Lakhmidas Mody...	24	0	0
,, Dayaldas Haridas	24	0	0
,, Shivjee Morarjee	24	0	0
Mrs. Krishnalal M. Javeri	24	0	0
Mr. Mathuradas Ravajee	24	0	0

Subscription List—*contd.*

	Rs.	a.	p.
In memory of late Mr. Manekji Dinshaw Katali	24	0	0
Mr. Jethabhai Veerjee	24	0	0
„ Veerjee Gangajar	24	0	0
„ Damodar Jutha	24	0	0
„ Chaturbhuj Nathu	24	0	0
„ Jamnadas Purshotam	24	0	0
„ Ratanjee Jivandas	24	0	0
„ Goculdas Damodardas	24	0	0
„ Narottamdas Jagjivan	24	0	0
„ Rughnathdas Khimchand	24	0	0
„ Keshavjee Bhavanjee	24	0	0
„ Jayaram Jivram (Calcutta)...	17	0	0
A Zoroastrian Lady	15	0	0
Mr. Manilal Lalchand	15	0	0
"T. R."	15	0	0
A Gentleman	12	0	0
Mr. Gordhanlal Lallubhai	12	0	0
„ Motilal Vallabhjee	12	0	0
„ Mathradas Hariram...	12	0	0
„ Madhowjee Dayal Narsey	12	0	0
„ Balkisandas Karsandas Jarivalla	12	0	0
„ Visram Dhanjee	12	0	0
„ Morarjee Vandravan	12	0	0
„ Goculdas Naranjee	12	0	0
„ Ramjee Gordhandas	12	0	0
„ Vullabhdas Meghjee	12	0	0
„ Pudumsey Munjee	12	0	0
„ Keshawjee Haridas	12	0	0
Bai Heerabai, widow of Govindjee Hansraj	12	0	0
„ Motibai, daughter of Mr. Girdhardas Jethabhai	12	0	0
„ Velbai, daughter of Mr. Girdhardas Jethabhai	12	0	0
Mr. Kallianjee Vachhraj...	12	0	0
„ Purshottam Lakhmidas	12	0	0
„ Anandjee Valjee and Mathradas Morarjee	12	0	0
„ Dharamsey Damodar	12	0	0
„ Manilal Bechardas	12	0	0
„ Jamnadas Narandas	12	0	0
„ Govindjee Premjee	12	0	0
„ Talakchand Jethabhai	12	0	0
„ Purshottum Dayal Nursi	12	0	0
„ Jamnadas Uallabhji	12	0	0
„ Bhawanidas Kashidas	12	0	0
„ Javer Jagjivan	12	0	0
„ Rawji Naranji	12	0	0
„ Chimanlal Sakerchand	12	0	0
„ Lalji Narayanji	12	0	0
„ Laxmidas Lalji	12	0	0
„ Kanji Khushal	12	0	0
„ Gopalji Kalianji (Singapore)	12	0	0
„ Manji Keshavji	12	0	0
„ Ramdas Kursandas	12	0	0
„ Morarji Govindji	12	0	0

Subscription List—*contd.*

	Rs.	a.	p.
Mr. Viseser Manilal	12	0	0
„ Morarji Virjee	12	0	0
„ Bhimji Umersey	12	0	0
„ Haridas Umersey	12	0	0
Servants of Mr. Ramdas Madhawji	12	0	0
Mr. Cawasji Temulji	12	0	0
„ Damoder Kursandas	12	0	0
A Lady	12	0	0
A Lady	12	0	0
Mr. Anandji Hirji	12	0	0
„ Bhogilal Samaldas	12	0	0
„ Manmal Gulabchand	12	0	0
„ Ranchhoddas Moolj	12	0	0
„ Ranchhoddas Dayal	12	0	0
„ Permanandas Chatterbhuj	12	0	0
„ Jethabhai Khimji	12	0	0
„ Pranjivan Vussanji	12	0	0
„ Dwarkadas Shamji	12	0	0
„ Devidas Shamji	12	0	0
„ Ranchhoddas Dayal, Trustees of Late Mr. Pragji Rawji...	12	0	0
„ Narandas Harjivan	12	0	0
„ Jivandas Damoder	12	0	0
A Gentleman, through Mr. Purshotum Govindji	15	0	0
Mr. Nand Ramdas Dwarkadas	12	0	0
A Gentleman, through Mr. Pragji Vandravan	12	0	0
Mr. Ganeshram Muchhal	12	0	0
„ Govindji Morarji	12	0	0
„ Bechardas Tricumjee	12	0	0
„ Valjee Dharamsey	12	0	0
„ Rugnathdas Hurjeevan	12	0	0
„ Manordas Varjeevandas	12	0	0
„ Lakhmidas Cooverji	12	0	0
„ Nagardas Parmananddas	12	0	0
„ Manilal Ghelabhai	12	0	0
„ Chandulal Rangildas	12	0	0
„ Rajaram Balmucandas	12	0	0
„ Dharamsey Canjee	12	0	0
„ Madhavjee Narsey	12	0	0
„ Laljee Jeevraj	12	0	0
„ Premjee Dossa Gheevala	12	0	0
„ Ramchandra Ranchhoddas	12	0	0
„ Gordhandas Jethabhai	12	0	0
A Gentleman	12	0	0
A Gentleman	12	0	0
Mr. Mognibhai Bhagavandas Mehta	12	0	0
„ Meherwanji Jehangirji Mehta	12	0	0
„ Vallabhdas Kalianjee	12	0	0
„ Haridas Keshavjee	12	0	0
A Gentleman	12	0	0
Shri Laxmi Narayan	12	0	0
A Lady	12	0	0
Mr. Shivlal Lallubhai	12	0	0

Subscription List—*contd.*

	Rs.	a.	p.
Mr. Purshotamdas Pranjivandas	12	0	0
„ Keshavji Hirji	12	0	0
„ Chaganlal Hemraj	12	0	0
„ Morarji Premji	12	0	0
Messrs. R. P. & Co.	12	0	0
Mr. Mehta Maneklal Mangaldas Nalawala	12	0	0
„ Dwarkadas Raoji	12	0	0
„ Narsinhdas Jivraj	12	0	0
„ P. B. Waiter	12	0	0
„ Dalal Laxmi Narayan	12	0	0
„ Jamnadas Mulchand	12	0	0
"T. L."	12	0	0
Mr. Kackara Manekchand Pragji	12	0	0
Vakils and Establishment of Court of Vanthali	12	0	0
Mr. Damji Bhanji	12	0	0
„ Girdhardas Goculdas	12	0	0
„ Bechardas Kalidas	12	0	0
„ Gopalji Kalianji (Singapore)	12	0	0
„ Chunilal Motichand	12	0	0
„ Jagumal Asanmal	12	0	0
„ Jutha Shamji	12	0	0
Bai Veerbai	12	0	0
Mr. Vallabhram Omarsing (Karachi)	12	0	0
Bai Ratanbai M. Mehta	12	0	0
Mr. Lallubhai Nagardas	12	0	0
Bai Parvatibai, widow of Nagindas Harjivandas	12	0	0
Mrs. G. M. Watchmaker	12	0	0
Mr. Gopaldas Liladhar	12	0	0
„ Karsandas Sunderji	12	0	0
„ Monjee Devchand	12	0	0
„ Bhagvandas Jetha	12	0	0
„ Thackersey Dayal	12	0	0
„ Khimji Damji	12	0	0
Mandvi Telegraph Writers' Association	12	0	0
Mr. Nensi Varsi	12	0	0
„ Varajlal Khimchand	12	0	0
„ Bhaiya Alla	12	0	0
„ Harilal Vijbukandas Sutaria	12	0	0
„ Maganlal Harilal	12	0	0
Messrs. Dinshaw Master & Co.	12	0	0
Mr. Gordhandas Manjee Morbiwalla	12	0	0
A Gentleman	12	0	0
Mr. Mathuradas Doongersey	12	0	0
In Memory of his daughter Jamnabai (Mr. Mathuradas Doongersey) ...	12	0	0
Mr. Jinabhai	12	0	0
In Memory of Mr. Sorabji Manekji Sethna	12	0	0
A Hindu	12	0	0
Bai Lilavati Ramdas Narandas	12	0	0
„ Prem Cooverbai	12	0	0
A Hindu widow	12	0	0
Mr. Harilal Pranshanker	12	0	0
„ K. N.	12	0	0

Subscription List—*contd.*

	Rs.	a.	p.
Mr. Maganlal Chunilal	12	0	0
„ Bhojak Jayashanker Bhudhar	12	0	0
Messrs. Ranchoddas Goculdas & Co.	12	0	0
Mr. Nathu Jetha	12	0	0
„ Durgadas Devidas	12	0	0
Mrs. Kasturbai Durgadas...	12	0	0
Bai Harakhbai	12	0	0
Mr. Bhatt Ishwar Bapu	6	0	0
„ Purshotamdas Karsandas	12	0	0
„ Dulabhbhai Makanji...	6	0	0
„ Himatlal Narsidas Dhebar (Junagadh)	5	0	0
„ M. S. Mody	5	0	0
In Memory of a Nagar gentleman's deceased wife	5	2	0
Mr. Gulabdas Nanabhai	5	0	0
Clerks of Mr. Talukchand Jaitha	4	0	0
Messrs. Jetsapam & Co.	2	0	0
Mr. Danawala Pralan Hansraj	2	0	0
A Hindu Lady	2	0	0
Bai Ganga Bhawanishanker	2	0	0
Mr. Ranchoddas Girdharlal	2	0	0
Four Brahmins	1	4	0
A Gentleman	1	0	0
A Gentleman	1	0	0
Mr. K. D. Merchant	0	6	0
Total ...	9,707	12	0
Grand Total of Contributions and Donations Rs....	3,46,417	9	6

Parcels of wearing apparel from—

A Sympathiser, Surat (with Re. 1 in cash).
Sardar Harcharansing, of Patiala.
Mr. Tulsidas Lallubhai Mody, of Bombay.
Rao Bahadur Ramnarayan Amarchand, of Poona.

APPENDIX E.

Statement showing total quantity of Hay and its cost as purchased by this Fund.

Serial No.	Name of person or body through whom hay was bought.	Quantity.	Cost in Rupees.
			Rs. a. p.
1	Mr. Tribhovandas Gandabhai of Umbergaon ...	28,876,775	4,69,116 7 9
2	The Conservator of Forests, Indore State	5,001,121	54,902 5 2
3	Mr. Bhikabhai Laxmidas of Bamania	591,941	7,087 4 3
4	Mr. S. G. Gogate of the Servants of India Society.	60,050	336 0 0
5	Mr. Tarachand Dhanjee (Sanvordem hay) ...	31,658	316 9 3
6	Servants of India Society (in U. P.)	338,128	2,976 1 8
7	Kadabi (from Bardoli)	15,611	187 5 3
8	Mr. Devdhar (Bhopal hay)	50,000	350 0 0
9	Cotton seed husks (from Manhar Bros.)	845,874	12,397 5 7
		35,811,158	5,47,669 6 11

Statement showing despatches of hay and cotton-seed husks to some of the important Committees, Panjrapoles and Native States from this Fund.

Total despatches of hay and cotton-seed husks (not including Rs. 9,000 worth cotton-seed husks sold at Cutch-Mandvi) ... ... lbs. 35,811,158

lbs.	8,631,585	sent against payment at cost price.
,,	24,497,563	sent against payment at cheap rates (including cotton-seed husks lbs. 845,874).
,,	2,755,278	sent for free distribution.
lbs.	35,884,426*	

The following are the names of some of the principal importers of hay from this Committee :—

	lbs.
The Kathiawar Central Famine Relief Committee (for Halar, Gohilwad, S. M. E., &c.)	4,407,981
Administrator, Porbunder	1,567,595
Chief Karbhari, Rajkot	1,477,750
Bhownagar Famine Relief Committee	1,052,190
Sihore Mahajan	465,675
Morbi	327,685
Political Agent, Gohilwad	2,637,687
Political Agent, Jhalawad	2,334,692

	lbs.
Chief Karbhari, Limdi	530,760
Superintendent, Managed Estates (direct from this Committee)	325,450
Administrator, Palitana	196,375
Botad and Ningala (for Rabaries' cattle)	1,049,210
Bedi Bunder (for Khambalia Gaushala)	415,900
Collector, Ahmedabad	1,132,223
Patri Mahajan	273,475
Naib Dewan, Idar State	124,350
Sarkhej Mahajan	118,414
Co-operative Credit Societies	365,020
Administrator, Balasinor	380,495
Vadnagar Cattle Camp	310,605
Vadnagar (Valabhram Kalidas)	195,620
Political Agent, Mahi Kantha	2,237,665
Thakore, Shree Varsoda	49,725
Karbhari, Bhadarva	119,955
Matar (for cheap sale)	244,575
Through Mr. Monjee Mowjee	901,970
Political Agent, Palanpur	138,240
The Famine Relief Committee, Jambusar	102,625
Mauli	738,140
Collector, Kaira	5,688,239
Collector, Ahmednagar	225,618
and several other smaller quantities.	

Statement showing despatches of Hay and Cotton-seed husks made to the various districts by this Fund.

Serial No.	Name of District.	Quantity in lbs.
1.	Kaira District	6,807,960
2.	Mauli ,, ...	776,580
3.	Punch Mahals District	842,525
4.	Rewa Kantha Agency	758,075
5.	Mahi Kantha ,, ...	3,315,902
6.	Palanpur ,, ...	138,240
7.	Gujarat	4,579,126
8.	Kathiawad	18,204,175
9.	Ahmednagar District	225,618
10.	Broach ,, ...	102,625
11.	Cutch ,, ...	133,600
	Total lbs. ...	35,884,426*

* Out of this total quantity lbs. 73,268 were rebooked to Ahmednagar from Viramgaum, Sarkhej and Wadhwan as same was not required there, and hence the total of despatches exceeds by lbs. 73,268, the total purchases.

The following list shows various stations to which Hay and Cotton-seed husks were consigned.

	lbs.
Viramgaum	206,534
Sarkhej	618,710
Ellis Bridge	234,465
Asarva	442,195
Bavla	99,105
Khodiar (Jamietpur)	39,655
,, (Adalaj)...	55,925
Ahmedabad	15,860
Patri	654,019
Kharaghoda	122,815
Deesa	138,240
Cambay	534,365
Petlad	128,335
Tarapore	120,360
Nar	101,030
Agas	127,200
Baroda	20,565
Sabarmati	37,590
Patan	10,800
Mehsana	23,430
Jhotana	384,815
Dabhoda	565,591
Mahadevpura	468,545
Sonasan	56,640
Talod	223,539
Randheja	396,772
Limbodra	484,518
Himatnagar	62,325
Jadar	231,480
Idar	238,970
Vadnagar	520,736
Rakhial	92,075
Moraiya	43,125
Barejadi	45,472
Lodra	49,725
Harij	23,410
Prantij	21,425
Bahucharaji	7,685
Pansar	19,165
Vadali	10,240
Stations in Kaira District (through the Collector)	5,833,579
Nadiad	681,485
Mehemdabad	480,350
Dakore	239,510
Vasad	129,840
Umreth	63,595
Anand	21,725
Thasra	56,610
Kharsalia	421,720
Godhra	73,000

Sevalia	438,692
Timba Road	42,860
Samalaya Road	44,155
Derol	119,580
Champaner Road	347,805
Masor Road	102,625
Mauli	738,140
Sanwar	38,440
Ahmednagar	152,350*
Kathiawar—	
Wadavan	1,607,032
Paneli Moti	514,065
Rajkot	2,708,875
Morbi	711,392
Vankaner	161,365
Botad	2,577,519
Porbunder	1,567,585
Limdi	1,082,370
Chuda	261,120
Balva	82,705
Kundali	34,595
Than Road	261,870
Dhola Junction	1,758,269
† Bedi Bunder	540,645
Bhownagar	1,052,190
Ningala	478,360
Lathi	1,269,748
Jalia	71,715
Songadh	326,886
Sihor	465,675
Muli Road	11,775
Jam Jodhpur	106,470
Ujalvar	18,635
Supedi	18,635
Pad Dhari	96,935
Chital	45,950
Lakhtar	12,020
Gondal	100,975
Dhoraji	30,325
Palitana	196,375
Sundries	8,030
† Tuna	33,600
	35,811.158‡

* Besides this lbs. 73,268 more were sent to Ahmednagar but as this quantity was rebooked from Sarkhej, Viramgaum and Wadhvan it is not shown here.

† Lbs. 100,000 were also sent to Cutch which quantity is included in the total shown against Station Bedi Bunder.

‡ Lbs. 73,268 are not included in the total despatches as same was rebooked to Ahmednager from Viramgaum, Sarkhej and Wadhwan.

APPENDIX F.

Extracts from Final Reports of Officers and Local Committees in the affected areas.

Extract from the Annual Report of the Register, Co-operative Credit Societies, Bombay Presidency :—

57. *Famine Relief.*—More than 40 Co-operative Societies came within the area of the Gujarat Fodder Famine. It was thought that there could be no better way of bringing home to the ryots the advantages of self-help and co-operative credit than by showing them how to obtain fodder through the agency of their societies. As the Collectors concerned had no objection to this course, I approached the Bombay Central Famine Relief Fund which very kindly agreed to distribute part of its help through the channel of the societies and to supply them with hay at a fixed rate of Rs. 12-8-0 per 1,000 lbs. carriage free. The Central Bank on its part agreed to advance loans at 7 per cent. to societies for this purpose and to pay the money direct into the Famine Relief Fund. In this way 341,465 lbs. were despatched to 11 societies, of which 5 took loans from the Bombay Central Bank and remainder paid from their own funds. *Hay of good quality was promptly* despatched from stations in Thana District by Mr. Purshotamdas Thakordas, the Secretary of the Fund, as soon as indents were received from me. I should like to express my great obligation for his effective help and the remarkable way in which he overcame the difficulties of transport.

Report of Mr. Otto Rothfield, I.C.S., Collector, Broach.

Report on the operations of the Jambusar Famine Relief Fund Committee and of the Mamlatdar, Wagra, out of the grants placed at their disposal by the Bombay Central Famine Relief Fund Committee.

Before October last was over it was apparent that there would be a fodder scarcity throughout the district, the worst affected parts being Wagra and Jambusar. The normal fodder supply in these tracts is deficient even in a normal year and the scanty rains of 1911 made the situation serious. The situation was from the beginning grasped both by local officers and non-officials.

In March steps were taken by me to raise a local fund to assist in directions in which Government could not undertake relief. A Committee was formed for the management of the funds and the distribution of relief both to cattle and men was organized. But as the situation got more serious by the end of March it was realized that some help from outside would prove of great value. The subject was represented to the Central Relief Fund Committee, Bombay, who allotted Rs. 1,000 to each of the Talukas of Wagra and Jambusar on 13th May last. This initial grant was subsequently supplemented by additional grants given at some intervals and the total of the grants thus given amounted to Rs. 6,500 for Jambusar Taluka and Rs. 3,500 for Wagra Taluka. It need hardly be said that the grant served *a very useful purpose* in tiding over a difficult period.

In Jambusar, as observed before, the Funds were managed by a Relief Committee who had also raised a local fund for relief operations. The relief was given in various forms. Corn was distributed gratis to those who were helpless and destitute. Grass was purchased by the Committee and distributed among the deserving. The work of distribution was carried out by volunteers.

On 16th June 1912, the average number of men and cattle getting relief per day was 2,131 and 1,469 respectively. The final accounts of the Committee are not yet received and so no full details can be given for Jambusar Taluka, but it may be remarked that the work was carried out efficiently by all concerned.

In Wagra there was a small local fund. The amount of the Central Committee's grant was Rs. 3,500. In this Taluka the Relief Operations were *personally conducted by the Mamlatdar.* The *Mamlatdar reports* that old, blind and infirm persons whom it was not feasible to maintain from any village fund were granted grain doles under the strict supervision of Village Committees. The dole lists were inspected by the Circle Inspectors and the Mamlatdar to see that only the needy got the relief and that the relief was promptly given. The expenditure in this account amounted to Rs. 1,437-8-0.

The *second form of relief* was the giving of petty amounts for seeds and grass. The total expenditure in this item amounted to Rs. 1,745-9-0. The chief recipients of grants were Vartanias, Dheds and Bhangis who were entirely resourceless.

The third form of relief was the giving of clothes and grain to the poor. This amounted to Rs. 224.

There is still a balance of Rs. 397-15-0 with the Mamlatdar. The amount is reserved for distributing wheat seeds to *those who have no means to purchase them.*

A true spirit of co-operation between the local officers and the non-officials was observed and great credit is due to the Jambusar Relief Committee for efficiently carrying through the relief operations.

In conclusion, the Collector takes this opportunity of thanking the Central Famine Relief Committee for their timely and generous grant to the district.

Extracts from the Ad Interim Report of the Kathiawar Central Famine Relief Committee.

17. The Gohilwad Prant, in the beginning, required our help as much as Halar. When in the beginning of March it badly wanted grass, but we had no grass to send, we sent at once Rs. 1,000 on 2nd March 1912 to the Political Agent, and requested him to purchase grass and satisfy the most pressing demands. Those six to eight weeks, beginning from the 1st of March, were according to the Political Agent very critical as the chhasatia was not then ready. Then came *the most welcome and opportune grant* of Rs. 7,500 which at the request of the Vice-President the Bombay Central was very kind to make to Gohilwad. It was their first grant to this Committee. In lieu of that grant, the Hony. Secretary of the Fund was requested to send 5 lakhs of lbs. of grass to Songadh and Dhola for Songadh Thana, and 7,50,000 lbs. to Lathi and Botad for the Babra Thana. The grass was to be sold at Rs. 10 per 1,000 lbs. The proportion of the grass to be sent for Songadh and Babra was settled by the Vice-President upon information he had received from the Deputy Assistant Political Agent, Gohilwad, and the Thandar of Babra. This proportion seems to have been subsequently readjusted by the Political Agent and the grass sent for Babra was lbs. 6,77,710 and for Songadh was lbs. 6,37,471. The entire quantity was *sent with the greatest possible dispatch in a very short time in the latter half of March. This, I am glad to say, saved the critical situation.*

* * * * * * * * *

20. The distress this year was mostly due to the insufficiency of fodder. It was pre-eminently a fodder famine. Of human distress there was very little and that little the Committee was able to mitigate with the help of whatever funds it had at the very beginning of its formation. But its funds were by far too little to meet, to any appreciable extent, the greater and overwhelming distress due to the fodder famine. There was also the difficulty of procuring grass and the still greater difficulty of importing it even when it was purchased. The Wadia Trustees were fortunately able in the month of February to pour into the province (Rajkot Civil Station, Rajkot Town and Porbandar) within a short time about 10 lakhs of grass for sale at cost price. If this had continued, the rate of grass would have gone down as the Wadia Trustees' grass was sold at the maximum rate of Rs. 12-8-0 when the market rate was Rs. 20. But that good fortune did not steadily continue. The Trustees were unable

to continue their consignments of grass after the 20th of February or to resume them till towards the end of March, though they had purchased 24 lakhs of lbs. for cheap sale in this province. Thus the beginning of March was a very anxious month for the province and for the Committee. There were pressing demands for grass coming from Gohilwad and Dhrafa, and all that the Committee could do was to send them what money could then be spared and ask them to buy grass with it if they could. Thus the Committee were helpless. At this time came to our rescue the Bombay Central Famine Relief Fund and its most energetic Hony. General Secretary and Treasurer, Mr. Purshotamdas Thakurdas. The former made liberal grants and the latter poured into the province with an almost marvellous dispatch, whatever grass was required. This generosity the Fund very kindly continued to the very last and the activity and energy of Mr. Purshotamdas also continued unabated. Not only to this Committee did he supply grass, but to any State or institution whatever that wanted grass and could pay the cost price, he sent grass with equal dispatch. Thus we are informed he sent about 175 lakhs lbs. of grass to this province. The Committee have therefore to tender their very best thanks to the Bombay Central Famine Relief Fund and their Hony. General Secretary and Treasurer Mr. Purshotamdas Thakurdas.

APPENDIX 4.

A Statement of accounts relating to the grass supplied by the Bombay Central Famine Fund to the different depôts in Kathiawar at the request of this Committee.

Serial No.	Name of the officer in charge of the depôt.	Quantity indented for.	Quantity according to invoices.	Quantity actually received.	Price at Rs. 10 per 1,000 lbs.	Cost price.	Freight paid.	Amount payable to the Bombay Central Famine Relief Fund.	Remarks.
1	2	3	4	5	6	7	8	9	10
					Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	
1	Divisional Manager, Chotila	200,000	220,570	201,711	2,017 1 10		255 10 0	1,761 7 10	
2	,, ,, Paliyad	200,000	199,605	183,832	1,838 5 1		239 8 0	1,598 13 1	
3	,, ,, Songadh and Vahiwatdar of Bhojawadar ...	175,000	195,675	187,125	1,871 4 0		247 4 0	1,624 0 0	
4	Divisional Manager, Wadhwan	200,000	201,485	186,227	1,862 4 4		171 15 0	1,690 5 4	
5	,, ,, Babra	100,000	97,230	90,112	901 2 0		140 5 0	760 13 0	
6	,, ,, Bhoika	100,000	94,725	87,043	870 6 11		90 9 0	779 13 11	
7	,, ,, Jhinjhuwada	100,000	97,225	91,627	916 4 4		86 12 0	829 8 4	
8	,, ,, Limbda	45,000	51,015	51,015	510 3 0		76 2 0	434 1 0	
9	Thandar, Babra	750,000	677,710	659,043	6,590 6 10		641 4 0	5,949 2 10	
10	,, Songadh	500,000	637,471	637,471	6,374 11 4		699 0 0	5,675 11 4	
11	,, Dhrafa	528,000	546,820	499,344½	4,993 7 1		851 10 0	4,141 13 1	
12	,, Maliya	200,000	205,075	190,330	1,903 4 9		464 7 0	1,438 13 9	
13	Superintendent, Fodder Depôt, Rajkot ..	975,000	975,000	890,706	8,907 1 0		1,167 7 0	7,739 10 0	The Rajkot fodder depôt sold grass to the residents of the Rajkot C.S., Lodhika Thana, and small Talukas in Halar and sometimes even to the neighbouring villages of larger Talukas.
			4,199,606	3,955,586½	39,555 14 6		5,131 13 0	34,424 1 6	
	,, ,, ,, ,, ..	100,000 @ Rs. 15	99,510			1,538 4 10		1,538 4 10	
	,, ,, ,, ,, ...	200,000 @ Rs. 17	126,790			2,214 14 5		2,214 14 5	
			4,425,906					38,177 4 9	

A Brief Report on the operations of the Bombay Central Famine Relief Fund Committee in Kaira District by Mr. A. Chuckerbutty, I.C.S., Collector, Kaira.

On November 30th, 1911, Mr. G. K. Deodhar, one of the Honorary Secretaries of the Bombay Central Famine Relief Fund, sent to the Collector a printed copy of the Prospectus of the Committee and desired him to intimate the minimum amount of relief required for the Kaira District (human beings and cattle) under the heads sketched out in the prospectus. After certain negotiations the Committee voted in the first instance Rs. 1,500 for A—human relief and Rs. 5,000 for B—cattle relief.

A—Human Relief Rs. 2,300.

2. The amount of Rs. 1,500 was distributed as under :—

Taluka.	Amount.
Thasra	Rs. 600
Kapadwanj...	„ 300
Matar	„ 200
Mehmedabad	„ 200
Nariad	„ 200
Total ...	Rs. 1,500

3. Rs. 400 more were subsequently granted for human relief, Rs. 200 each for Anand and Borsad Talukas.

4. The total number of units relieved out of this grant of Rs. 1,900 amounted to Rs. 34,489. Relief was given in 287 villages and lasted for nearly 3 months except in Anand where relief work commenced in April and lasted till 15th June.

5. Besides this Rs. 400 were specially granted for the relief of respectable poor persons in Thasra Taluka and 160 such persons were relieved with the help of this grant.

6. The cash grant of Rs. 5,000 for the relief of cattle, voted by the Committee, was distributed as under :—

B.—Cattle Relief.
(a) Cash grant of Rs. 5,000.

Rs. 3,000	Thasra Taluka.
„ 2,000	Matar Taluka.
Rs. 5,000	

These were the most affected parts of the District. 1,717 cattle-owners were helped out of this cash grant. The system generally adopted was to sell grass at Rs. 8 per 1,000 lbs. debiting the difference between Rs. 8 and the cost price to the Committee's cash grant. In some cases when the grass thus sold at cheap rates happened to be very dear the purchasers were given help of Rs. 5 to Rs. 8 per 1,000 lbs. generally to enable them to make purchases according to their buying capacities.

7. A sum of Rs. 12,500 was allotted to this District in two instalments for the supply of cheap fodder by the Committee. To look after the prompt and proper despatch of grass to this District the services of Mr. S. G. Gogte, a member of the Servants of India Society, were made available. Mr. Gogte undertook to work hand in hand with Government officers for the relief of distress.

B—Cattle Relief.
(b) Paper allotment of Rs. 12,500.

8. The Collector had an offer of grass of about 100 lacs lbs. from the Conservator of Forests, Indore State. He placed this offer in the hands of Mr. Gogte, who went to Indore and secured the contract with the Collector's help. He stayed there and personally looked after the operations on the spot. These arrangements quickened the despatch of grass and lessened anxiety as to the supply. The difficulty of transport, however, was very serious and the

Collector had to intercede with the Railway authorities. After strenuous efforts the Collector succeeded in securing special grass trains for the Committee's grass.

9. The total import of this grass amounted to 5,688,239 lbs. It was sold at rates varying from Rs. 8 to Rs. 12 per 1,000 lbs. according to the condition of the recipients who numbered 6,604 in all. The cheap sale of the Committee's grass resulted in a loss of Rs. 7,162-8-5. The expenses incidental to the transport of the grass were Rs. 3,806-11-4. A sum of Rs. 1,530-12-3 thus remained unexpended with the Committee out of the allotment of Rs. 12,500 voted for this District.

B—Cattle Relief.
(c) Further allotment shortly before the commencement of rains.

10. The rains unfortunately did not set in, as usual, in the beginning of June. With the drought continuing the situation grew more serious. The Committee on being informed of the situation *at once* offered a helping hand and placed Rs. 5,000 at the disposal of the Collector for cattle relief purposes and despatched 145,340 lbs. of grass, the cost thereof being met out of the grant of Rs. 5,000. In the first week of July, however, good rain happily altered the situation and the last mentioned grant was reduced by Rs. 1,000 in view of the fact that Ahmednagar then stood most in need of help.

Free distribution of seed.

11. Out of this grant of Rs. 4,000 Rs. 2,212-15-8 were saved as under :—

Rs.	a.	p.	
937	3	0	Cash received from the Committee.
1,275	12	8	Sale proceeds of the Committee's grass at Rs. 12 per 1,000 lbs.
2,212	15	8	

The Committee permitted the same to be utilized for free distribution of seed. 774 needy poor cultivators were served with the help of this grant.

D—Kachha wells Rs. 2,000.

12. During the month of March the supply of drinking water in wells ran very short. The low castes were the first to suffer; for their immediate relief the Committee sanctioned a grant of Rs. 2,000 and suggested that the work of providing kachha wells and deepening and repairing pacca wells for low caste people should be taken in hand. Rs. 1,000 were accordingly placed at the disposal of each of the two Assistant Collectors. This grant was further supplemented by Rs. 1,000 from the District Local Board Funds. Colonel Blowers of the Salvation Army was entrusted with the District Local Board grant of Rs. 1,000. Out of the Committee's grant of Rs. 2,000, 28 wells were rendered serviceable. 11 kachha wells were dug and 13 pucca wells were deepened by putting in Kathwas, 2 wells were cleansed, 1 well was repaired and 1 was newly constructed. All these wells were meant exclusively for low caste people, such as Dheds, Bhangis, Chamars, etc.

A sum of Rs. 235-12-11 is reported to have remained unspent. It is reported that this unspent balance is required to complete the repair works. The Collector has not yet made up his mind whether this balance should be returned to the Committee or retained for expenditure during the fair season, though the latter course certainly seems to him advisable seeing that the present abnormal rains are likely to render considerable repairs necessary to the low caste wells especially.

Acknowledgment to the Committee.

13. The Collector begs to acknowledge most gratefully the assistance rendered to the District from time to time and for various objects by the Bombay Central Famine Relief Committee. The assistance offered by allotting Rs. 5,000 towards the end of the season and just before the commencement of the rains when the situation was becoming exceptionally critical was especially valuable.

Acknowledgments to Mr. S. G. Gogte of the Servants of India Society.

14. Mr. S. G. Gogte, B.A., of the Servants of India Society, rendered valuable help in purchasing grass and in personally supervising the arrangements connected with the baling and despatch of grass to this District. He did this at the cost of considerable personal inconvenience and trouble and his dealings with the Collector and all the officers under him

were throughout harmonious. He kept himself fully in touch with the Collector and his officers and offered valuable suggestions from time to time as he gained experience and it was through his co-operation that the Collector was able to arrange for the speedy taansport of grass by Rail to the affected localities. His services deserve special commendation.

Acknowledgments to the Honorary General Secretary Mr. Purshottamdas Thakordas.

15. The Collector has special pleasure in acknowledging the thoroughly co-operative harmonious and courteous spirit displayed throughout by the Honorary Secretary Mr. Purshottamdas Thakordas. He evinced a real interest in his work and a very sincere desire to meet distress as far as it lay in his power. Specially gratifying was the readiness with which he voluntarily offered his assistance and despatched to this District nearly 1½ lacs lbs. of grass towards the end of the season when grass from other sources was getting scarce and the situation gave rise to considerable anxiety. Mr. Purshottamdas has proved conclusively how Government and private agencies can work side by side in perfect harmony and without friction of any sort.

Extract from the Administration Report of the Porbunder State for the year 1911-12.

135. Since then except for 3 lacs out of the 14 lacs bargained for, from the Wadia Trustees and about an equal amount from Dhank near Vansjalia, the Sanstha is getting hay at cost price through Mr. Purshottamdas Thakordas, the Honorary Secretary of the Bombay Central Relief Committee. His timely help was really God sent. No more grass was available nearer hand, and no wagons could be had for bringing the hay already bought at Billimora and from the Wadia Trustees and we were afraid of our labour and money spent till then, being wasted and the cattle starved ; but the regular consignments from Mr. Purshottamdas began to pour in and saved the whole situation. The promptness of despatch, regularity of consignments and the businesslike dealings of this energetic and unsparing gentleman were simply admirable.

Extract from the Report of A. F. Maconochi, Esq., I.C.S., Collector of Ahmednagar.

With reference to the 3rd paragraph of your letter, dated the 8th August 1912, I have the honour to send you four statements comprising the accounts in connection with the money and grass you kindly sent to this District. Statements Nos. III and IV show not only the method of distribution, but also the names of persons who were most useful in co-operating with me in the work of relief. I feel sure what small relief was afforded, reached all classes of recipients, and we one and all are so infinitely grateful to you and your Committee for all the help you gave us at a time when it was so sorely needed.

STATEMENT I.—Cash received from the Bombay Central Famine Relief Fund.

Reference.	No. of Cheque.	Amount.
		Rs.
Letter, dated 4th June 1912	B-1010600	1,000
,, ,, 18th June 1912	B-1019460	1,000
,, ,, 11th July 1912	B-1019477	1,000
,, ,, 8th August 1912	B-1019495	2,000
Total amount received ...	.....	5,000

STATEMENT II.—Grass received from the Bombay Central Famine Relief Fund.

Date of Reference.	Station of Despatch.	Railway Receipt.	No. of Waggons.	No. of Bales.	No. of Pounds.
13th July 1912 ...	Palghar...	B-27536	2	101	15,945
„ „	„	B-27537	4	179	29,415
17th July 1912 ...	„	B-27538	7	354	56,990
25th July 1912 ...	Wadhwan	A-7806	3	75	11,000
„ „	Bhopal	A-2369	9	290	50,000
27th July 1912 ...	Viramgaon	B-9183	6	180	34,268
„ „	Sarkhej	A-42685	3	126	28,000
	Total ...	.....	34	1,305	225,618 lbs.

Extracts from the Report of Captain A. S. Meek, Political Agent, Gohilwad Prant.

3. After the first grant of Rs. 7,500 from your Committee, arranged through the agency of the Rajkot Committee, I carried on negotiations with you directly and received further grants of Rs. 4,000 and Rs. 1,500, with one of Rs. 500 for the Vala Taluka, all of this money being placed by you to my credit to cover the loss on grass sent me by you for sale at Rs. 10 per 1,000 lbs. This total of Rs. 13,500 represents supplies of grass to the aggregate of 19½ lacs of pounds, practically the whole quantity being for the Babra and Songadh Thanas.

4. In addition to this grass I have purchased from you at full cost grass to the value of Rs. 37,000, Rs. 28,600 of this sum being subscriptions to my Cattle Fund and Rs. 3,000, profits made by me on sales, the balance Rs. 5,400 being the price paid by buyers at full rates. This money represents 18½ lacs of lbs. of grass approximately, making a total quantity of fodder sent including cotton seed husks of 20½ lacs lbs. The cotton seed husks it may be noted were found excellent, though it required much demonstration and persuasion to get the people unaccustomed to them to see their value.

5. Now as to the result of all your work on our behalf, I have already stated your first speedy delivery of 12 lacs of lbs. of grass for cheap sale was our salvation in a very critical time Our cattle were for the most part at home. Some had been taken by their owners to the Gir but most had been brought back again; some had gone beyond Kathiawad altogether. But speaking generally, the cattle were all at home with their own people; and I had decided not to countenance cattle camps, but to keep the cattle at home. And your help made this very successful. All along people were able to supplement your supplies with, in the case of cultivators and landlords, green fodder raised by irrigation (for much attention was given to wells and the water supply in most cases remained fairly good) and in that of other, any old fodder available and burnt up roots which alone had begun to be refused by the cattle. The final result is that only a very few agricultural cattle have perished of starvation, the mortality there has been among these animals being chiefly due to excessive work at irrigation with nourishment insufficient under such circumstances. In one village practically all the plough cattle died, but that was a striking exception, and the fact is due to the utter worthlessness of the local girasias. Mortality among other cattle there has been. The proportion, which I am not at present able to quote, is however very small and casualties were among old animals chiefly and the very young. The better animals have not suffered. Buffaloes were so zealously cared for, and that at the expense of the less valuable cow, that at the beginning of the rains a drove of cattle presented a curious picture, the emaciated cow staggering out to the young grass side by side with the buffalo sleek and ponderous as in times of plenty. Enough then for the cattle. Had the people been left to themselves there would have been disastrous mortality: as it is there has been no serious loss. Sheep perished in considerable numbers and it was not unfortunately possible to do anything for them.

6. In addition to grass supplies we have received from you Rs. 850 for wells and Rs. 1,000 for the purchase of plough bullocks, and these sums have been spent under my own direction in accordance with your wishes. Further, my Deputy Assistant is administering a fund for human relief to which you subscribed a sum of Rs. 756. The money has been and is being usefully expended.

7. As I informed you in my letter No. 2567 of 16th July 1912 the people here are deeply sensible of all that has been done on their behalf. Their gratitude to your Committee and all who have worked for them is often demonstrated and is the most pleasing feature of our famine administration.

8. You have requested me to furnish you with a short report and I have overstepped the limit I should have set. I will only remark in conclusion that if we have achieved *any success* in our famine operations here in respect of the salvation of cattle *we owe it in great measure*, nay almost wholly, *to your Committee. You saved our position at the most critical time and maintained the security you established till the end. It was only through your agency* I was able to speedily apply the money collected for my Cattle Fund. I have conveyed you my hearty thanks many times, both to yourself personally and to your Committee and in concluding now I can only repeat them again.

Extract from the Report of Mr. J. S. Kadri, B.A., Administrator, Balasinor State.

In all we actually received 356,403 lbs. of hay from you out of the total consignment of 390,495 lbs. despatched by your Agent, thus leaving a deficit of 34,092 lbs. *The deficit was partly due to natural wastage and dryage and partly to thefts and dishonest practices at various places.*

* * * * * *

The Famine Fund grass was given away to most needy and deserving people either free or at reduced rate of Rs. 10 per 1,000 lbs.

In all free grass was given to 265 persons and cheap rate grass to 65 persons.

The amount realized out of the grass sold at cheap rate was again utilized in the purchase of new grass.

For all this aid, I have to thank most heartily the Committee of the Famine Central Relief Fund Committee and particularly your goodself and Lady Volunteers on behalf of this State. Your indefatigable efforts and untiring zeal which were evident from your sympathetic inquiries and prompt replies to my representations, cannot be too much extolled. Your reward lies in the imperishable legacy of countless blessings of the suffering humanity and animals relieved by you and in the Divine Grace of Providence, the Father and the Ruling Spirit of the Universe.

Extract from the Report of Lt.-Col. H. D. Merewether, Political Agent, Palanpur.

One factor which helped to save the situation was the fact that the people of Tharad and Wao after their experiences from previous famines had kept large reserve stocks of grass for the last five years, so that apart from their own requirements it was found possible to purchase grass from these districts for the assistance of other Talukas. In all Rs. 26,136-8-2 were collected in the Charity Fund, of which Rs. 15,000 were contributed by the Bombay Central Famine Relief Fund for the purchase of cheap fodder, Rs. 5,000 for human relief and Rs. 2,000 for giving subsistence allowance to poor cultivators. Thus the Bombay Fund contributed in all Rs. 22,000 to this Agency. My thanks are due to Mr. Purshotamdas Thakurdas, Honorary General Secretary and Treasurer of the Bombay Central Famine Relief Fund, and his committee for their generous response to my appeals. The total quantity of grass given in each Taluka at cheap rates was :—

	lbs.
Kankrej	300,000
Deodar	464,320
Warahi	372,680
Wao	168,800
Santalpur	260,800
	1,566,600 lbs.

Of this quantity 160,000 lbs. were imported through the Bombay Charity Fund, the rest was purchased in Wao and Tharad villages. Mrs. Ramabai Ranade and other Lady Volunteers distributed clothes and grain to pardanashin women and other persons of good family after personally satisfying themselves of their wants. The Trustees of Sheth Wadia's Trust Fund contributed Rs. 1,000 for subsistence to poor cultivators and Rs. 2,136-8-2 were contributed from other sources. Valuable assistance was rendered by Mr. Ratansi Mulchand of Mota Jampur and others in the relief of distress generally.

* * * *

24. *A valuable lesson has been afforded during the recent scarcity* of the advantage of stacking fodder in years of plenty for use in years of scarcity. Every State and Taluka should make an invariable practice of stacking grass in each year of good rains to fall back upon in bad years. Tharad and Wao had an ample supply of grass for their own use during the recent scarcity, and were able to help other Talukas which had been less provident. I am endeavouring to arrange with the States and Talukas that they will in future make a rule of keeping as far as possible a supply of two years' grass in reserve.

25. *A second lesson to be drawn from the past year* is that irrigation by wells, if carried out in time, are a most valuable means of providing green fodder in times of famine. To this end it is of importance that cultivators generally should be encouraged in every possible way to construct "pucca" wells which owing to the existing insecurity of tenure they are in many places unwilling to do. That this insecurity may be removed it is desirable that as remarked above in para. 13 of the Thara Jagir, the lands in Talukdari villages generally should be classified and a Vighoti system introduced which will not permit Talukdars to oust satisfactory tenants as they can do now. This would eventually be as much to the interests of the Talukdars themselves as of their cultivators and will, it is hoped, and believed, prove practicable. This has already been done to a small extent by agreement with the Talukdars in the Deodar Thana. It is hoped to take up the question generally and to submit proposals for the approval after the expiry of the present scarcity.

Extracts from the Report of Major N. S. Coghill, Political Agent, Mahi Kantha.

7. The total quantity of grass supplied to this Agency by the Committee was 22,37,909 lbs. which was distributed as under:—

7,43,330	Bawisi Thana Circle.
5,62,165	Dabhoda (excluding 15,000 lbs. sent to Sadra).
1,81,165	Rakhial (including 15,220 lbs. sent to Ilol).
2,01,380	Sabar Kantha, Thana Circle.
3,84,774	Katosan, Thana Circle.
2,74,970	Sadra Bazar and Vasna Taluka (including 15,000 lbs. received from Dabhoda).
2,29,510	Pethapur Taluka.
1,71,380	Ilol Taluka (exclusive of 15,220 lbs. received from Rakhial).
2,32,565	Khadal Taluka.
22,37,909	

8. The above figures indicate the quantity despatched by the Committee, but the actual quantity received at stations of destination amounted to 20,55,962 lbs. and the deficiency owing to dryage, wastage and loss during transit amounted to 1,81,947 lbs.

The *deficiency* is no doubt excessive and every important deficiency was brought to the *notice of the Railway authorities. The usual* reply to the queries addressed to the Station Masters about the deficiency was that the Railway was not responsible for loose consignments

of grass. The arrangements for transhipment of grass at the Station of Asarwa on the A. P. Railway from Bread-gauge wagons to those of Metre-gauge was very unsatisfactory and to such an extent did confusion arise that consignments meant for one station were delivered at another and sometimes even waggons were missent. This has been reported to the General Traffic Manager of the B. B. & C. I. Railway. Another difficulty also in procuring a prompt supply of grass was owing to the failure of the Railway authorities to supply a sufficient number of wagons at the stations of despatch.

20. In conclusion the undersigned, on behalf of his predecessor Major J. W. B. Merewether, himself, and the poor cultivators of the Agency, expresses very grateful thanks to the Bombay Central Famine Relief Fund Committee for its very liberal help in saving the lives of the cattle many of which in the absence of this assistance would not have outlived the calamity which confronted them. The undersigned also must not conclude without expressing his sincere thanks to Mr. Purshotamdas Thakurdas, the Honorary General Secretary and Treasurer of the Committee, for his ready and willing help in placing the applications of this Agency from time to time before the Managing Committee and for the prompt supply of grass from distant parts of India.

Extracts from the Report of Mr. C. J. Mehta, Deputy Assistant, Political Agent, Rewa Kantha.

In the beginning, difficulty was experienced in getting carts to fetch these bales from Derol to Pandu and within Pandu Mewas limits since bullocks had grown weak so much so that good many pauper owners of cattle who were offered charity grass could not take the bales home for their own cattle from Derol and those from Sehore and such other distant parts of Mewas did not or rather could not take advantage at once of those bales even after they were brought to Pandu. At this juncture, some Pandu cartsmen who had good bullocks were persuaded by our Thandar of Pandu to fetch on hire the charity bales, etc., from Derol and the work of distribution of this grass at cheap rates was progressing thereafter fairly well after ascertaining who were the needest pauper that required fodder for their cattle in the different parts of Pandu Mewas. At Gothda the work of distribution was done very expeditiously, since the difficulties just mentioned were not felt there and the waggons received there were distributed among the pauper there only within three days of receipt of the bales at the Timba Road Station. This was just what was wanted since Gothda and Jesak were parts most in need of fodder in Pandu Mewas.

It is no exaggeration to say that this charity grass and cash contributions out of the proceeds of the same, supplied by the Bombay Central Famine Relief Fund Committee through your personal exertions, has saved many a cattle of Pandu Mewas and Bhadarva State from the jaws of death and starvation and the Committee and your goodself have received the everlasting blessings of these dumb creatures and poor ryots.

An Extract from the Report of Mr. M. H. Kothawalla of Godhra.

Allow me please to make a particular mention here, about the prompt and timely help in grass, so kindly allowed to us by your Committee. There has been a heavy dearth of grass everywhere, and it was this kind help of grass in the beginning and the promptness with which you have kindly supplied me with grass through your grass Agents from time to time, which have gone a great way, to meet the increasing demand for enlisting more catttle, as the necessity arose ; and you must be fully complimented upon, for your prompt and able assistance everywhere, and for managing such a huge concern so ably and successfully.

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